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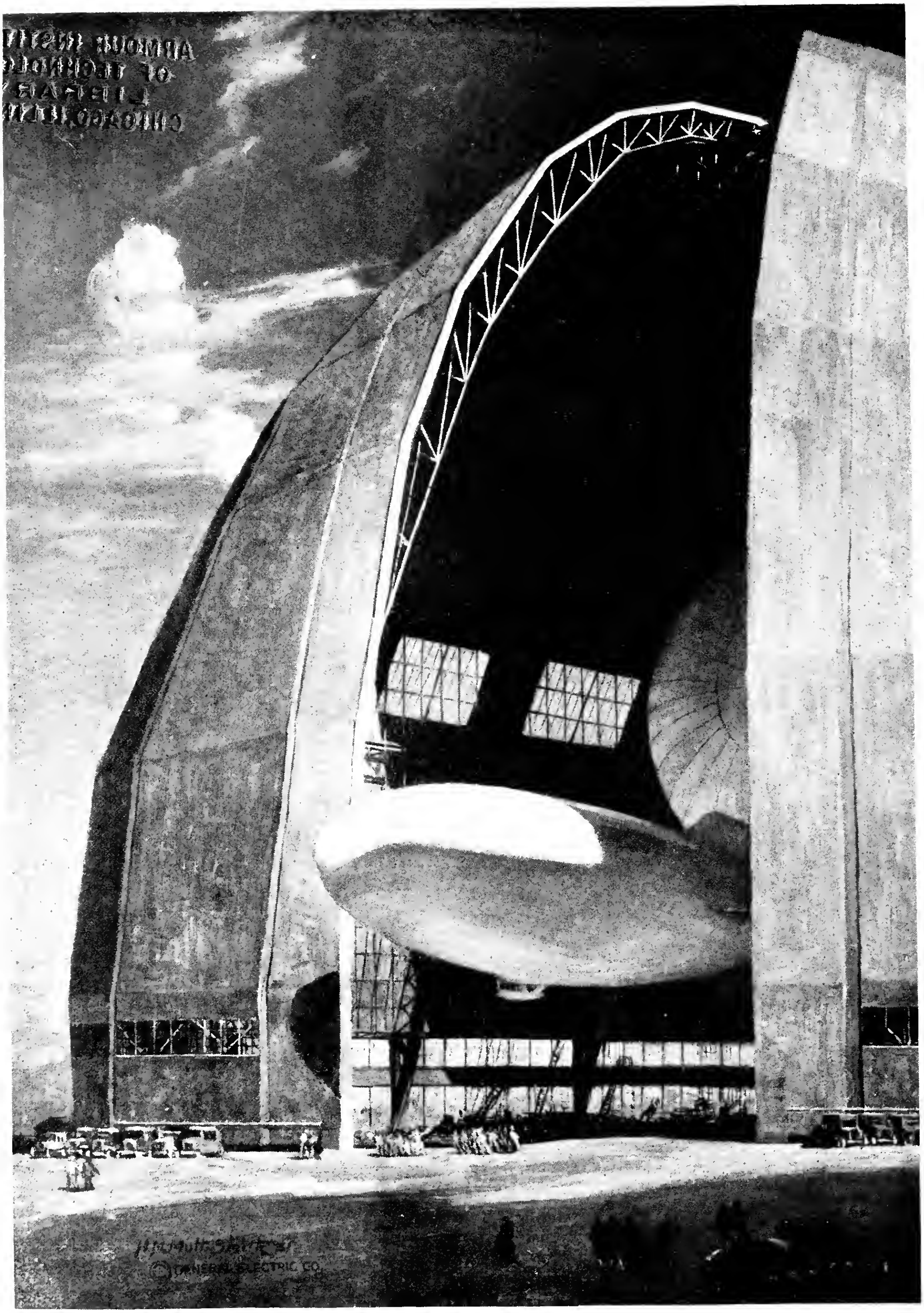


Science's Conquest of the Air

Courtesy General Electric Co.

THE ARMOUR ENGINEER

NOVEMBER, 1933

Equipment of Automotive Engineering Laboratory

By PROF. DANIEL ROESCH

EVERY laboratory, shop, and office has various specialized equipment, methods, and technique which are natural developments for peforming new inspections, or developments which obviously facilitate the conducting of routine work with greater simplicity or precision. Amplification of specific phases of the work at hand is an objective of these developments and usually includes the presentation of a final summary having improved clarity, comprehensiveness, and conciseness. The following description applies to some of these developments in the Automotive Engineering Laboratories of the Armour Institute of Technology.

Forward

The power determination of the auto-

Professor Daniel Roesch graduated from Armour with the degree of B.S. in Mechanical Engineering in 1904. In 1908 he was awarded the degree of Mechanical Engineer at the same institution. He came to the Institute in 1911 as instructor of Experimental Engineering. Since 1928, when he was promoted to Professor of Automotive Engineering, he has remained with the school in that capacity.

motive engine requires a device with the ability to absorb steadily and measure accurately power at a wide range of speeds and loads. For this work the electric cradle dynamometer has intrenched itself as the favored method. Briefly a direct current generator usually designed with inter-pole and pole-tip windings is fitted with field and armature controls so that a wide range of speed and load is permitted without sparking at the commutator. The entire field frame is mounted on sensitive ball bearings to permit the direct measuring of the torque. The power may then be computed from the torque and speed without using generator efficiency measurements. This dynamometer may be used as a generator for absorbing power or as a motor for transmitting power. It becomes a versatile tool for determining the power delivered *to it* from prime movers of any kind or for determining the power delivered *by it* to drive pumps, fans, engines (for friction power) or any device requiring power. The Automotive Laboratory at the Armour Institute of Technology has a 300, 100 and a 20 horsepower electric cradle dynamometer of standard commercial manufacture and a ¾ horsepower unit which was made up in the laboratories. The largest machine has been operated as low as 25 R.P.M. and as high as 3500 R.P.M. without noticeable sparking at the brushes. The smallest machine has proven especially helpful in determining the power requirements of small equipment such as magnetos, fans, etc.

Power Measurements

The electric cradle dynamometers as furnished by the manufacturer are complete and dependable units requiring only routine servicing for obtaining good results over a long period of use. It has, however, been found desirable to add knife edges at the same radius as the load weighing knife edges so that calibration with standard weights is facilitated. In later years these knife edges have often been added as factory equipment. For highest accuracy in motoring tests, or any tests where a small difference of power measurements is of importance, special calibrations are made by suitable prony brakes directly connected to the shaft of the dynamometer. This has been found necessary for power-loss tests of high-efficiency gears or tests where the power transmission efficiency is close to 100 per cent and a critical comparison is made of relative losses. The use of a large water-cooled prony brake drum at low speeds may drag the water around without filling the drum to a uniform depth. This action is particularly observable when changing from a static condition to a low speed of operation. The water in the drum is dragged around to a position of unbalance and gives erroneous readings of torque. The remedy has been to correct for this in the data or preferably to furnish water only in quantities that will be continuously evaporated.

Mixture Ratio Measurements

The mixture ratio of air and fuel is one of the most important characteristics that is desired for the analysis of internal combustion engine performance. The orthodox method is the direct measurement of the quantities of air and fuel supplied to the engine. An index to the mixture ratio may

also be obtained from exhaust gas analysis. Some of the special equipment used for this phase of engine inspection in this laboratory are a Gasoline Weighing Meter, a Multiple Orifice Type Air Meter, Rounded Entrance Nozzles, a Bureau of Mines Orsat Apparatus and a Moto Vita Exhaust Gas Apparatus or Combustion Indicator built by the Moto Meter Gauge & Equipment Company, Toledo, Ohio.

Fuel Measurement By Weight

The direct measurement of the quantity of liquid fuel which is supplied to an engine is preferably made on a weight basis in order to avoid any correction necessary for the density or volume changes of the fuel with temperature. Fig. 1 shows the external appearance of the Weighing Machine or Meter as developed in this laboratory. Fig. 2 shows the schematic arrangement of the parts and the electric circuits which automatically keep the machine in a readiness-to-test position and automatically start and stop the watch at the beginning and end of a run. The length of run will be dependent upon the selected weight of fuel used in any particular case and may be from 0.025 to 1.0 lb. or more.

This machine is extremely fast and accurate and requires very little time for manipulation and observation. Based on a four minute run for the smaller weight and a thirty second run for the one pound weight, the capacity of the machine ranges from a fuel rate of 0.4 lb. per hour to 120 lb. per hour or about 0.07 to 20.00 gallons per hour. At any of these rates the accuracy is essentially that of the stop watch reading. The device may also be used to remotely start and stop the engine revolution—counter at the beginning and end of the fuel test. This avoids taking engine

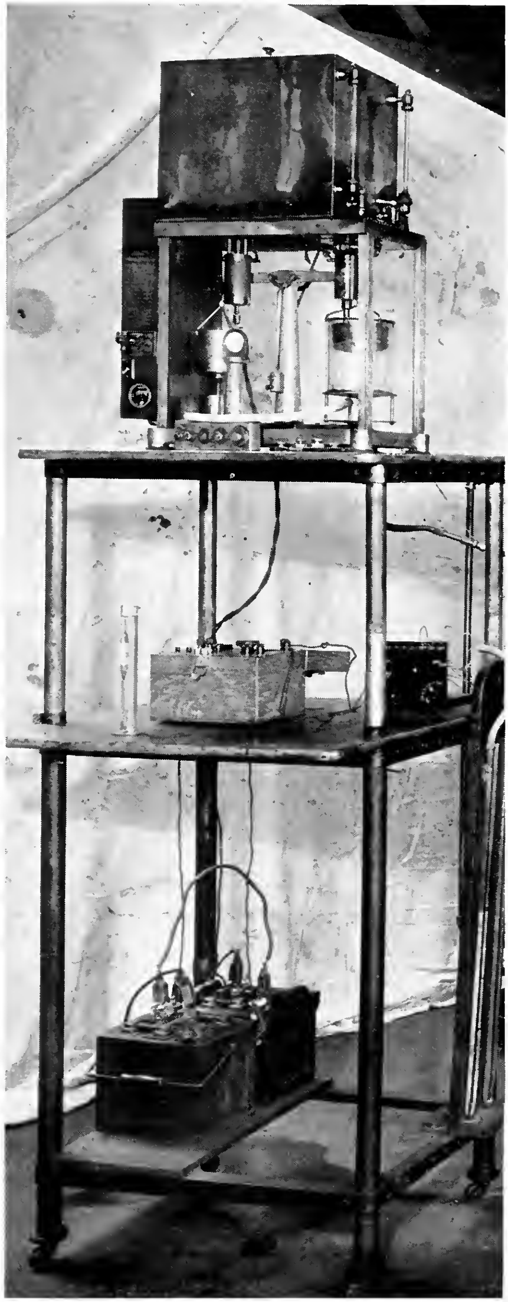


Fig. 1.

speeds over a period of time which is not concurrent with the fuel consumption determination. This item does not have importance when the engine speed is uniform but in cases where the "drift" or "float" in engine speed is appreciable, it makes for more reliable data. Fuel tests as short as 30 seconds duration have been practical in many instances. This facilitates observing the gradual changes in fuel flow rate after making adjustments to a new test condition and permits noting when an equilibrium flow condition has been attained. Quantities are successive isolated in time intervals as low as 40 seconds with gravimetric-flow-rate errors under one per cent.

Operation of Gasoline Weigher

On the right arm of a sensitive beam scale mounted on knife edges is hung a glass container, which supplies the metered fluid to the engine being tested or to any other device using liquids in amounts within the capacity of the meter. On the left arm of the beam scales is hung a counterweight. The glass container is intermittently supplied with fuel from the copper reservoir at the top. (This reservoir has two compartments so that either of two liquids is available by manipulation of proper stopcocks). The glass container is automatically held at nearly an even balance by a solenoid-operated valve which intermittently supplies fuel from the main reservoir and thus continually replaces fuel which the engine uses. With the master control switch (shown on the box at the left of the instrument) thrown to the right, this intermittent feed to the glass container will continue as long as the engine uses fuel. Tests can be started at any time that the valve is not supplying fuel to the glass container, i. e. when the glass container side is heavy. The test is started by throwing the master switch to the left. As the glass container becomes lighter it rises to an even balance with the counter-weight and closes the mercury contact near the lower part of the center post of the beam scale. This contact carries the primary current of a relay and a current of about 1/10 amp. The secondary of the relay starts the stop-watch. At any time after the watch is started and before the end of the run the desired weight is added to the pan under the glass container. This makes the right side of the beam go down, where it remains until a weight of fuel, equal to the selected test weight, is used by the engine. A second rising of the glass container again operates the platinum-mercury contact and stops the watch. This records the time necessary to use the selected weight of fuel. After noting the time as registered by the stop-watch, the master switch is opened and then closed again to the left in order to reset the stop-watch to zero. The master switch is then thrown to the right and the test weight removed from the pan. This will refill the glass container with the fuel used during the test and will thereafter maintain the level and balance so that the meter is again in readiness.

The actual operation of the meter requires little time, as is indicated by the following instructions for operating:

For Automatic Filling:

Throw master switch to the right.

For Testing:

(1) Throw master switch to the left whenever glass reservoir is not filling.

(2) After watch starts, place desired weights on pan.

(3) At end of run, read the watch.

(4) Open master switch and close again to left. This resets watch.

(5) Throw master switch to right and remove weight from pan in readiness for the next test.

The weights used for testing are placed on the same side of the beam scale as the glass container for the fuel. This arrangement prevents errors due to unequal lengths of balance arms which may be caused by knife-edge wear or otherwise. The personal element of reading fuel levels, starting watches and reading flow meters is eliminated since the beam scale movement closes the electrical circuit which operates the stop-watch and counter. The beam is subjected to the same weight at the beginning and end of the run and hence is subject to the same inertia effects and sensitivity for the beginning and end of the run. Runs of 30 seconds to one minute may be made with a fuel determination error of approximately 0.5%. Runs may be made for any weight of fuel from 0.025 lb. up to 1 lb. or more by increments of 0.025 lb. This entire range is provided for by six test weights (which have been standardized on chemical balances). This range of weights permits adjusting the time of a test run as desired.

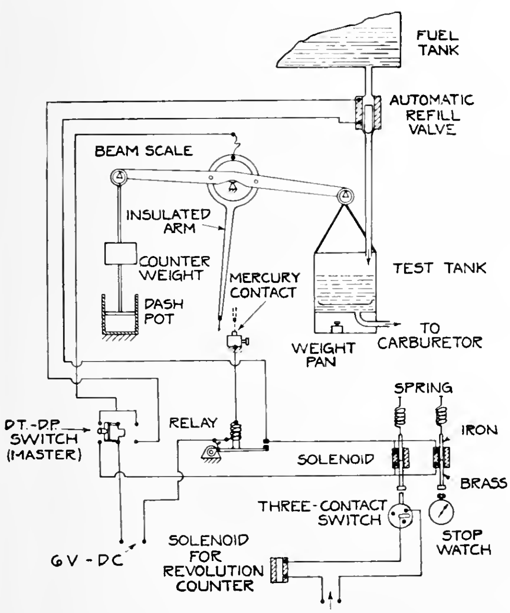


FIG. 2

When the master switch is thrown to the right the meter holds itself in readiness to test by intermittently feeding fuel to the glass container in amounts corresponding to approximately 1/16 to ⅛ inch variation of level. The maximum time necessary before starting a test will be that required to use this amount of fuel. The operator's time is not, however, required since he can throw the master switch to the left and the fuel test will start automatically at the proper time. The weight is placed on the pan at any time before the conclusion of the test run. The fuel test will then stop automatically and the readings can be made at the convenience of the operator.

The primary electrical contact of platinum and mercury is made by an ingenious arrangement which permits of a long horizontal motion and positive break of the platinum tip. The mercury is forced vertically out of a long thin slot which is at right angles to the motion of the platinum tip. The height of the mercury can be readily adjusted by means of a thumb

screw. The entire break can be covered with kerosene or light oil to give an oil switch effect when testing with highly volatile fuels. Such precautions have not ordinarily been considered necessary with motor gasolines unless the vapor pressure of the fuel at the room temperature is high. The gasoline supply to the glass container is open so that it can be seen. This does away with the uncertainty of leaks when using a three-way cock between the general fuel supply, the test supply and the engine feed. The automatic needle valve just above the glass container closes without dripping, thus insuring correct successive weighings.

Fuel Measurement By Volume

The laboratory has three types of volume measuring devices which are represented by Figs. 3, 4, and 5. Fig. 3 shows a simple and convenient arrangement of a glass tube of suitable size. It is fitted with an adjustable multiple hook-gauge of the surface piercing type, from which the level of the fuel may be determined accurately as the fuel is being consumed. The intervals between gauge points, 0-1-2 etc., may be a suitable number of cubic inches or cubic centimeters or may be made a definite weight of fuel provided there is no change in density. Time readings for the quantity used during a test permit computation of the flow rate. Fig. 4 shows a modification using two restrictions so that the level changes rapidly at the beginning and end of the test run. This construction permits the main reservoir to be metal with a gauge glass mounted adjacent for observing the fuel levels. The restrictions are adjustable and locked in final position and the volume selected is checked under flow conditions with the liquid which is being used. An auxiliary supply tank is used to refill slightly above the upper restriction.

Fig. 5 shows a volume measuring device in which the level of the fuel is indicated by a multiplying lever as shown. The central tube is used alone for small flow rates, while proper manipulation of the stopcocks permit the use of the annular volume

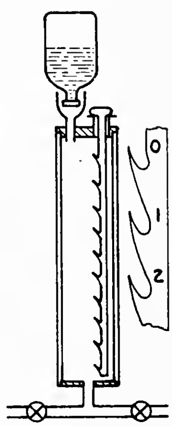


FIG. 3

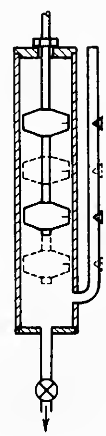


FIG. 4

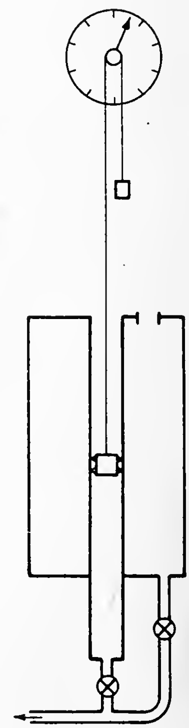


FIG. 5

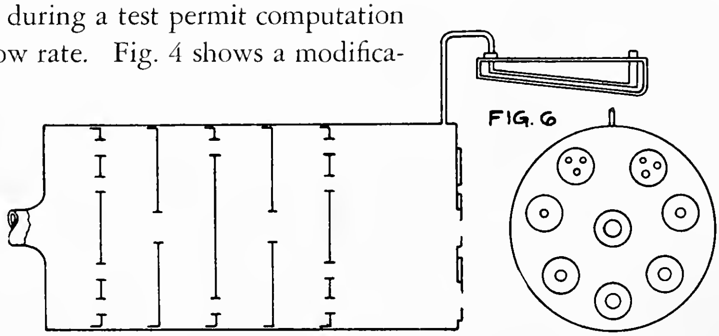


FIG. 6

or the annular volume plus the center tube. The device in use is arranged for double range operation but the selection of cross-sectional areas for the inner tube; outer shell and the annular space makes possible a triple range device. The inner tube with its multiplying indicator for the device as used is suitable for gasoline tests using as little as 0.03 pounds or about 20 cc per run and is advantageous when testing one horsepower engines at fractional powers.

Proper corrections for temperature changes must, of course, be made for all volume measurements.

Fig. 6 shows the view of a multiple-orifice type of air meter as developed in these laboratories. The orifices are thin-plate, sharp-edge types having experimentally determined coefficients for their specific operating conditions and are very similar in this respect to the Durley orifices.

Air Measurement Orifice Meter

Since the coefficient of discharge of orifices varies with the pressure drop and the diameter, the meter was simplified by using a fixed pressure drop of 1.5 inches of water. This necessitated multiple orifices to measure variable volumes. A series of orifices was selected to give the flow rates of 2, 4, 4, 10, 20, 40, 40, 120, 240, and 480 lb. of dry air per hour at standard pressure and temperature. The final adjustment of each orifice diameter was made by proving them against a wet displacement meter of known accuracy. The ten orifices permit observations up to approximately 1,000 lb. per hour, in 2 lb. increments directly, and 1 lb. increments by interpolation.

The operation of this meter then becomes simply the closing of sufficient orifices until the pressure drop is exactly 1.5 inches of water on the inclined manometer and observing the aggregate of the open orifices. Necessary corrections are, of course, made for atmospheric conditions of pressure, temperature and humidity and final observations may be on a dry-air or humid-air basis. If the air demand is uniform the manometer readings will be steady. Experience with this meter covering many years shows that it is fast, accurate and rugged. It is sensitive enough to indicate the slight drop off of air demand of an automobile engine which occurs directly after a heavier-load-test adjustment has been made and before thermal equilibrium has been attained in the combustion chamber. This tapering down of the volumetric efficiency which occurs when a heavier load test follows one of lower load, requires for essential equilibrium, only a short time for those tests where the thermal capacity of the engine is small as compared to the power being developed. In a converse manner the volumetric efficiency has an increasing drift when changing from a heavier to a lighter load. After thermal equilibrium has been established the drift of the pressure drop as shown by the manometer becomes a valuable index to speed changes or other disturbing factors in the operation of the engine. In general, this has been a very practical meter with the exception that the 1.5 inches of water pressure drop has sometimes been too great for best carburetor and engine performance and secondly, that the addition of piping to the intake system sometimes presents inertia effects that may be

of considerable importance particularly at resonance conditions.

When the 1.5 inches of water pressure drop is the only undesirable condition, the meter may be operated at one-half the indicated flows by using a pressure drop of 0.375 inches of water and taking into consideration the necessary slight changes of coefficients of the orifices.

Half Capacity Use

The inertia effects of the piping and resonance are not easily corrected and may introduce serious errors. One case of resonance extending over a speed range of from approximately 750 to 825 r.p.m. showed a peak flow observation about 40 per cent too high. The fact that this resonance effect is large is desirable since it is readily detected. The speed range from no resonance effect through a maximum and on to no effect, however, is rather small and any observation which appears out of line should be scrutinized carefully at closely neighboring speeds to determine whether or not there is a critical flow. It is largely because of the ramming and resonance effects which are present in all meters having considerable piping, that a series of rounded entrance nozzles are being developed to supplement the multiple-orifice constant-pressure-drop meter which is described above.

Inertia Effects and Resonance

Editor's Note: This is the first of a series of two articles by Professor Roesch. The second will appear in the January issue of "The Armour Engineer."

Teletype Printing Telegraph System

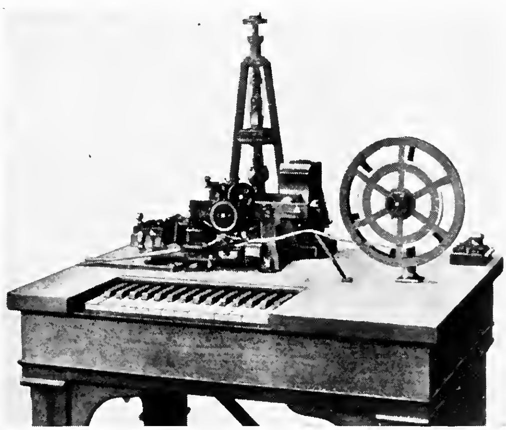
By A. S. BENJAMIN

TELETYPE printing telegraph systems represent the latest development of an art which is nearly a century old. A few years after the introduction of the Morse Telegraph in 1832, inventors began to consider means for automatically operating printing devices over telegraph wires. In 1837, Alfred Vail, an associate of Samuel F. B. Morse, prepared detailed drawings for such a system, but it was not until 1846 that R. E. House conceived a printing telegraph system which was put into practical operation between New York City and Philadelphia in 1849.

In 1856, David E. Hughes, with the assistance of George M. Phelps, introduced a more improved system, which was operated between Worcester and Springfield, Massachusetts. Although the Hughes-Phelps equipment resembled that used by House, it was based on a different principle and was found to be far superior to and eventually replaced the older system.

The accompanying figure illustrates the Hughes printing telegraph apparatus. It is to be noted that the messages are transmitted from a piano-like keyboard and printed on a tape from a typewheel. The sets were originally driven by weights but were later equipped with electric motors.

The Hughes printing telegraph system was followed by a number of others, the more important ones being Baudot, Siemens, Creed, Murray, Barclay, Rowland, Potts, Cardwell, Morkrum, Kleinschmidt



Hughes Printing Telegraph Apparatus.

A. S. Benjamin is an alumnus of Armour where he obtained the degree of B.S. in Electrical Engineering in 1917. Mr. Benjamin attended the Lane Technical High School of Chicago. He now holds the position of Sales Engineer with the Teletype Corporation.

and Western Electric. Several of these systems are no longer in use.

At the present time, Teletype Corporation in the United States, Creed in England, Lorenz and Siemens-Halske in Germany are practically the world's source of supply for printing telegraph equipment. Teletype systems today represent the combined efforts of the world's foremost communication engineers.

Printing telegraph equipment up to 1922 was practically confined to the commercial telegraph and railroad companies and it was not until 1922, when the Morkrum Company introduced the model 12 page Teletype set, that printing telegraph equipment was considered for general business use. This unit is a comparatively simple one, inexpensive as to initial and maintenance costs when compared to other systems then available.

The demand for printing telegraph equipment was further increased in 1925 when the Morkrum Company introduced the model 14 tape Teletype unit which included still further refinements in the printing telegraph art.

In 1930 Teletype Corporation went into the production of model 15 page Teletype equipment which represents the latest development in page recording printing telegraph apparatus and supersedes the model 12 sets.

Teletype may be best described as a distantly controlled typewriter. The unit which transmits or prepares the message for transmission has a bank of keys which resembles and is operated like the one on a typewriter. The recording unit has a platen which carries the paper and typebars (in some cases a typewheel) which are automatically selected and thrown against the paper to print the desired character.

The most commonly used and simplest form of Teletype unit is the model 14 direct keyboard tape recording "start-stop" set. On this instrument, the depression of a key first sets up a code combination corresponding to the character to be printed or the function to be performed and then disengages a clutch which connects a motor to a mechanism which transmits the code combination in the form of electrical impulses to all of the machines connected to the sending instrument.

These electrical impulses actuate magnets on all of the machines on the circuit, including the sending instrument and, through certain mechanisms, selects a particular typebar or position on the typewheel and causes the proper character to be printed on a narrow tape which is automatically spaced after each character is printed.

The most commonly used code is known as the five-unit Baudot code. The combination for each character or function consists of five elements of time during any of which we may have either of two conditions; in the case of the simplest circuit, current or no current, referred to as marking and spacing impulses. The five-unit code gives thirty-two different combinations and, on the tape recording Teletype set, three of these combinations are used for the shift, release, and space functions, leaving twenty-nine for the characters. The printer is arranged so that the paper can be placed in an upper or lower case

position with respect to the type pallets, thus making possible the printing of fifty-eight different characters.

A bell is also provided on the receiving units and is usually operated on the shifted position of the "J" or "S" combination. This bell is used for attracting the attention of the attendant at the receiving end of the circuit and for sending routine signals.

On "start-stop" systems, a spacing (start) impulse always precedes the impulses making up the code combination. This spacing impulse is transmitted as soon as the sending mechanism is put into operation and initiates the operation of the receiving mechanism on all of the receiving machines. The code combination impulses are then transmitted, followed by a marking (stop) impulse. The receiving mechanisms are stopped at the end of each cycle and are again started when the next start impulse is transmitted.

All machines on a circuit must operate at substantially the same speed in order that the sending and receiving mechanisms will always be in the same relative position. The motors which drive the Teletypes are equipped with governors which keep the speed of the motors within the required limits. When closely regulated alternating current power sources are available, synchronous motors may be used.

Teletype sets are also available in direct keyboard "start-stop" models which record the message on a wide page instead of a narrow tape. On the page machine two additional functions are required; namely, the carriage return and line feed. The depression of the carriage return key on the sending machine causes the paper on all of the machines on the circuit to be automatically placed in position to print the first character of the line. The line feed combination automatically feeds the paper through the machine. On the five-unit code page machine, twenty-seven combinations are available for printing, thus permitting the printing of fifty-four characters if desired.

The paper on the tape and page machines is usually in rolls and is automatically fed through the printer, thus making possible the recording of a message without an attendant at the receiving end of the circuit. Carbon copies can be made if required on both the tape and page machines.

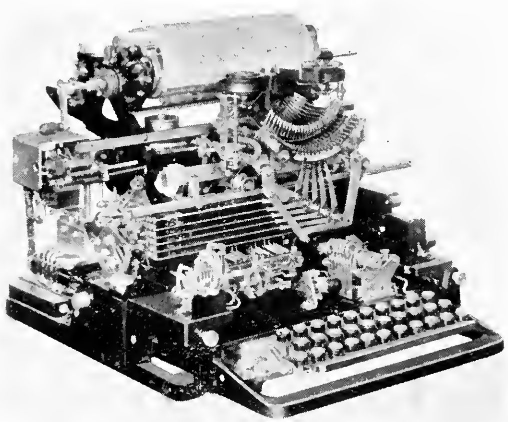
The page Teletype printing unit has been adapted to handle printed forms. The stationery is made continuous with holes along its edges and the printer platen rolls are equipped with pins which engage the holes in the forms. This arrangement prevents slippage of the paper and insures perfect registration of forms. As many as seven copies can be made at one time; if more than seven are required, several machines can be connected in series or recording ribbons used on the Teletypes and the required number of copies run off on a duplicating machine.

The tape recording Teletype set is applicable to installations where the messages are of a transitory nature, where it is not essential that the message be in a page form, or where it is economically feasible, as in the case of commercial telegraph routine, to paste the message on message

blanks. The tape instrument is particularly adapted to general commercial telegraph, stock quotation, broker, hotel, bank and fire alarm services.

Since the tape machines use a small paper carriage and do not require the carriage return and line feed functions and its associated mechanisms, that instrument requires less parts and has a lower initial and maintenance cost than the page machine.

The page recording machine is particularly adapted to general business needs since the message is ready for delivery as soon as it is recorded and thus eliminates the additional operation of gumming the tape onto message blanks. Multi-copies on plain paper and printed forms can be made on the page machines which cannot be produced on the tape printer. The convenience and decreased cost of handling general business messages on page machines in many cases offsets the slightly higher initial and maintenance cost of the page machine over that of the tape instrument.



Direct Sending Type.

There are two general methods of printing telegraph transmission, the direct sending keyboard previously described and the perforated tape. The depression of a key on the direct sending keyboard immediately sends the code impulses over the line. The direct sending keyboard is usually combined with a recording unit to form a combination sending-receiving set and when the keyboard is manipulated, a record of the transmitted message is made on the recording unit of the sending machine as well as on all other recording units on the circuit.

The perforated tape is prepared on a perforator unit controlled by a bank of keys similar to that on the direct sending keyboard. The perforator keys control six punches, which perforate a vertical row of holes in the tape, five of which punch the code combination and the sixth a hole for feeding the tape. Holes are perforated for the marking impulses of the code combination; no holes are perforated in the positions corresponding to the spacing impulses. The perforated tape is then passed over pins in a tape transmitter which sends the impulses out over the line and operates all recording machines, either tape or page type, which might be connected to the circuit. In many cases the perforated tape is sufficient record of the transmitted message and no printed record is made at the sending point.

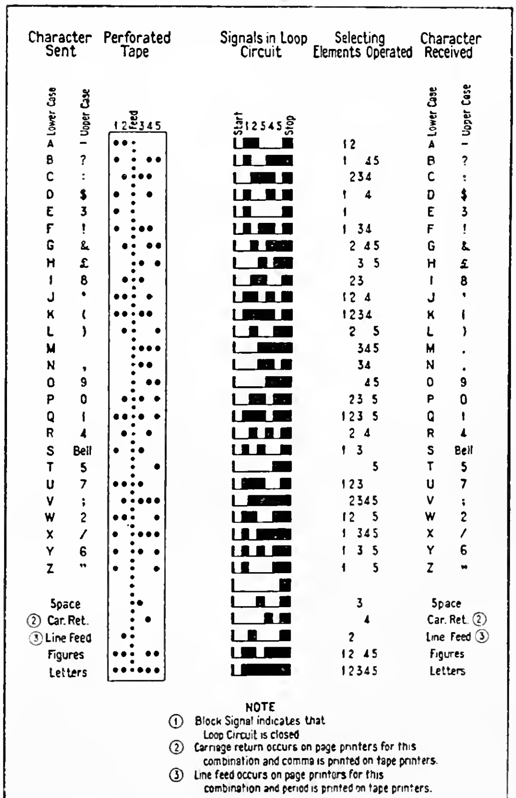
Continuous synchronism systems are also being extensively used. On this system, the transmitting and receiving apparatus is connected to auxiliary equipment which maintains the synchronism of the two ends of the circuit and also controls the trans-

mission and reception of the line impulses. At the present time, all continuous synchronism systems are arranged for multiplex operation, that is, the auxiliary equipment is arranged to give from two to four transmission channels in each direction over a single wire. This is accomplished by successively transmitting the impulses from each of the sending machines. On a four channel system, the five impulses of the first machine are transmitted and received at the distant end of the circuit. The five impulses from the second machine are then transmitted, followed by the impulses of the third and fourth machines. Tape transmission is used in connection with Multiplex circuits.

Multiplex systems are not as flexible and are more expensive than the "start-stop" systems and are therefore confined to installations involving widely separated points which have a large exchange of messages.

Teletype service has become almost indispensable in the conduct of the world's business. Press associations utilize nation-wide networks to disseminate the world's news; stock quotations are carried from the heart of New York City to thousands of brokers in the United States and Canada; criminals are apprehended by the use of Teletype. Each day telegraph companies carry nearly a million messages of joy and despair while hundreds of instruments carry weather and general flying information over thirteen thousand miles of United States Airways to make aviation safe for pilots and passengers. The efficient and safe operation of railroads depends to a considerable extent on the extensive railroad Teletype systems in the United States, Canada and other parts of the world. In fact, Teletype serves every imaginable business.

Teletype Printing Telegraph Systems provide an accurate, rapid and flexible means of communication, the message being recorded in legible typewritten forms. This type of communication makes possible the separation of the different units of a business so that offices and factories may be logically located with respect to markets, labor supply, material, power and transportation facilities. A business may have its office and factory hundreds of miles apart with a Teletype circuit con-



Five Unit Baudot Code.

necting them. If machines arranged for handling printed forms are used, it is possible to fill out the necessary copies of an order at the factory at the same time that copies are made at the sales office. All of this work is done by a clerk at the main office and the transaction is handled as if the sales office and factory were located on the same premises and the orders distributed by the local mail boy.

The development of Teletype systems has closely followed that of the telephone field, the following being some of the more general ones:

1. A sending-receiving machine connected to one or more receiving-only sets on a single circuit to provide one way transmission.
2. Two or more sending-receiving machines on a single circuit arranged so that all of the machines on the circuit will receive the message transmitted from any station on the circuit. It is of course obvious that receiving-only machines can also be connected into the circuit to record the messages transmitted by any one of the sending machines.
3. A number of machines, either sending-receiving or receiving-only, each equipped with selecting units, connected to a circuit so that any sending station can select any one, group, or all of the stations simultaneously.
4. One way radial systems consisting of a central station connected to a number of outlying receiving-only stations, and arranged so that the central point can send to any one, group, or all of the stations simultaneously.
5. Two way radial systems, consisting of a central office and a number of sending-receiving outlying stations so that the central station can send to any one, group, or all of the outlying stations, and any one of the outlying stations can send to the central office.
6. Full intercommunicating systems, similar to the two way radial systems with arrangements for interconnecting any two outlying stations on the system.

A number of Teletype systems use automatic switchboards which closely resemble those used for automatic telephone switching. Each Teletype station is provided with a control box consisting of a cam key, dial unit and lamp. If the calling station machine is idle the lamp on the control box will not be lighted and a connection can be established by throwing the cam key on the control box which corresponds to the lifting of the receiver on a telephone, and dialing the called station number. If the called station is not busy, the connection will be completed and the motors which drive the Teletype machines will start up, making possible the interchange of messages between the calling and called stations. At the completion of the message, the cam key at the calling station is restored to normal.

If the called station is busy, the connection will not be completed and the lamp at the calling station will light up, indicating this condition, in which case the control key would be restored to normal until such time as the station is not busy.

Airplane Propeller Testing

By ROBERT W. SUMAN

THE only method of propulsion through the air that has practical value today is by means of the screw propeller. This device is the "driver" of all types of airplanes and dirigibles. Even balloons use motors and propellers. There are hundreds of types and makes, and the merits of any one type are best found by testing. Scientific research has done a great deal to remodel the airplane propeller used previous to 1927 into a trim, efficient propeller that is dependable. The propeller of recent design is largely of metal, part being cored out. It is much stronger, free from trouble due to the weather, except for sleet, and far more efficient. Weight, the foe of the airplane, has been reduced to a minimum by the proper design and production. Formerly the large, wooden propeller was several times as heavy, not as strong nor as efficient as the new blade and, subject to deterioration due to the weather, it splintered easily.

Testing has brought about the alterations in propeller design that have changed them from large, weighty, bulky, inefficient masses into neat, light, highly efficient blades. The three types of testing that can be used are model, full scale, and full size wind tunnel tests.

Model testing is not very accurate due to the difference in tip speed, etc., and it is not used extensively at present. The results of the full scale and model tests on the same propeller showed the model tests to be 8% in error. Flight tests are still used and their accuracy is dependent upon the operators and apparatus. Wind tunnel tests are superior. With the new 20′ propeller, full scale tests can be made with cowlings on the motors and the whole plane in actual flying setup, so that actual flying conditions can be measured.

The flight tests involve much accurate observation of the many factors and corrections used to measure the efficiency of a propeller screw. The efficiency is the ratio of the power delivered to the power given the propeller.

$$\% \, E_p = \frac{\text{power delivered}}{\text{power received}}$$

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These powers are measured for the propeller as a unit. The power that propels an airplane through the air is called the power of propulsion. This is equal to the power of the propeller minus the drag of the plane. The efficiency of propulsion is equal to

$$\frac{\text{power delivered}}{\text{power of propulsion}}$$

In flight tests the power of the propeller is measured on a dynamometer, and then the engine and propeller are placed on a calibrated plane and their performance observed with precise instruments.

In order to get the power delivered by the motor at different speeds, the motor and propeller are mounted on a Sprague dynamometer and put to test in the conditions under which they will later drive the plane. 30-70 Benzol aviation gasoline is used, and the power delivery, consumption of fuel, and other items are carefully checked during this test. It is found that the power of a motor while in flight is 6% to 10% greater in some cases than it is in the stand. In one test, the power of the engine depreciated 3½% during the run due to wear, carbon, and other losses found in the engine after use. After making complete observations of temperatures, pressures of oil, and the effect and correction of changes of temperature and pressure, it is found that there are highly varied conditions of intake in an airplane carburetor.

The plane is then calibrated for various speeds between 50 and 135 m.p.h. This is done by actual flights, and the accuracy of the trials depends upon how accurately the observations can be taken. The plane is fitted with many carefully calibrated instruments, both on the fusilage and on the motor. Suspended from the plane, after it is in the air, is a trailing bomb inclinometer and an air-speed meter. It is a very sensitive instrument that is perfectly balanced by mercury so that, regardless of the angle of the plane, it remains in a horizontal position. Due to this fact it can measure the change in angle of a plane, and is accurate to 0.5° and reads from 0° to 16°. This gives the gliding angle of the plane in flight. There is also a Pitot tube air speed indicator, which has a high degree of accuracy. The N. A. C. A. recording pendulum and air-speed meter records the air speed at the wing and the angle of attack. It is oil dampened, but very accurate. Other instruments include the N. A. C. A. altimeter, accurately calibrated, and a distance thermometer mounted on the wing strut. In addition to all of these, the plane has the regular navigation instruments.

Instruments used to get observations of motor conditions, so as to know the power given the propeller, include an oil pressure gauge, oil temperature thermometer, and water temperature thermometer if the engine is water cooled. A Veeder revolution counter may be used, but a new, more accurate device is made so that for every so many revolutions of the camshaft an electric bulb flashes, affecting the sensitive film passing the point of light at a known velocity. By counting the flashes on the film in a length equivalent to 1 minute, the R.P.M. is found by multiplying by two, for the crankshaft travels twice as fast

as the camshaft. The barometer pressure is observed for two reasons: it is the controlling factor, along with the temperature, of the density of the air, and it controls the carburetor feed of air. It is found that the horse power of an engine varies with changes in density (p) and changes in absolute temperature (T) according to the equation $H.P. = \frac{Cp}{\sqrt{T}}$

From all data received on engine instruments, the power being delivered by the motor to the propeller is known from the test stand motor standardization. The plane is calibrated by flying it at various speeds between 50 and 135 m.p.h. Then with the propeller speed adjusted by the pilot to a calculated R.P.M., at which it has no thrust or drag, but is screwing its way into the air at the same speed that the plane is gliding, the plane is allowed to glide 40 sec., and the angle of glide, velocity, etc., are recorded from the instruments previously described. The angle of glide is the angle that the line of flight makes with the horizontal, and it is small. The component of weight along this line of flight, minus the drag, is equal to the thrust necessary to fly the plane under the given velocity. Therefore, the efficiency of the propeller can be determined by knowing the thrust and the power delivered to the motor. The efficiency of propulsion is the ratio of the power delivered to the propeller to the power necessary to propel the plane if no propeller was acting, and this would be the effect if the propeller was 1,000′ ahead of the plane so that its thrust would have no effect on the plane. Under these conditions, the efficiency of propulsion would equal the efficiency of the propeller instead of being less, as it usually is.

Wind tunnels are of recent design and the most elaborate one is a 20′ propeller research tunnel of the N. A. C. A. at Langley Field, Va. It is a wooden, steel framed tunnel, 56′ at its maximum height. The tunnel is in the middle of the building, and the test chamber, which holds the central position of the room, is 50′x55′x60′. It is well lighted with electricity. The cone is 36′ long and 50′ square at the end, and tapers down to a 20′ diameter. The exit cone is 52′ long, and the propeller is 28′. Guide vanes direct the air around the building, which has large air ducts in its sides, back to the entrance cone. They cut down all burble by correct guidance of the air. The air flow is produced by a propeller 28′ in diameter, with 8 aluminum, heat treated blades on a steel hub. A column of air the size of the entrance cone is moved at 100 m.p.h. past any object placed in the air stream, and the propeller speed is 330 R.P.M. The propeller is keyed to an 8′ steel shaft, supported by large, well lubricated bearings, which in turn are on steel "I" beams and "A" frames that are well faired for stream lines. Power for this massive propeller is generated by two Diesel engines developing 1,000 H. P. each at 375 R.P.M. They are former submarine engines, donated by the U. S. Navy. These are in an engine room of fireproof steel construction. Driving is made by 44 "Texrope" V belts that connect the sheave on the shaft to that on the motor. The entire engine room and the drive belts

are covered with corrugated metal on steel frame work, making the room fire proof.

The plane is set up between the entrance and exit cones in its typical flying position. The wings are either left off entirely or tested separately. For propeller tests the wing action is not important, so the wings are not on the fusilage. The fusilage is held in the air stream on three supports; one on each side of the landing gear, and one in the rear on the tailskid. The lower ends of these supports are resting on scales, and all the ends of the supports are pivot joints. The drag can then be measured by a balance that is connected by a linkage that holds the plane from being swept off the supports. The strain on that linkage is measured by the balance and, knowing the dimensions of the linkages, the actual drag can be computed. All supports and apparatus in the air stream are stream lined, and the gas and oil tanks are placed outside the wind tunnel so as to reduce the hazard of fire. They are connected by tubing to the engine. During the runs the scales are all read and the drag and twist, due to torque in the fusilage, can be found.

The motor is mounted on a torque dynamometer that is used for determining the power delivered by the motor. The dynamometer is a steel framework of a shape that will set in the fusilage. It has a steel plate and is set on bearings at its forward end. The motor is bolted to the steel plate. The torque is balanced by a dial scale reading the torque directly up to 2,000 lbs., and up to 4,000 lbs. with a counter weight. The engine starter is electric. It is let down into the tunnel, and engaged with a dog on the propeller shaft, driven to start the motor, and then pulled out of the tunnel for the remainder of the test.

The propeller blade is deflected, and the deflection increases as the observations are taken farther out or with a larger radius. The deflections are measured by a telescope mounted near the propeller. One blade and the background is painted black. Then with the proper lighting, the leading and trailing edges of the propeller can be seen, and from successive settings of the cross hairs on these lines, the angular deflection can be ascertained.

The conditions are kept as constant as possible. The air speed taken at about 30 intervals in the cross section, did not vary over 1% over the entire area. The air speed is measured by an accurate manometer that is checked by pilot tubes at definite intervals. An observer is stationed in the cockpit to read the torque meter and to control the engine. The dynamic pressure, torque, and R.P.M. are all measurable to within 1%, and this is sufficient to check up on any propeller. A more accurate result could be obtained, but the added trouble and expense do not warrant it considering that 1% error is a satisfactory result.

Some of the results have shown the speed of maximum efficiency and the proper strength of propellers. When the propeller is driven at excessive speed, a burble of air is found. At McCook Field, in one of their tunnel tests, it was found that this burble was so great that it shook the building, vibrated all of the dust off the tunnel, and could be heard. The tests also show that tail surfaces have no effect

on propeller performances, but if stub wings are put on the fusilage there is a noticed effect that needs further investigation. The actual speed of a propeller is the speed along a helical path, and tip speed $=\sqrt{F^2+R^2}$ where (F) is the forward speed, and (R) is the circumferential speed. The burble usually starts at 1,000 feet/sec. tip speed, where $\pi DN=1{,}000$. πDN used for tip speed is not over 2% in error of using $\sqrt{F^2+R^2}$ where $R=\pi DN$, (N) being the R.P.S. and (D) the diameter of the propeller in feet. Above 1,000 feet/sec. tip speed, a drop of efficiency is found, and is approximately equal to a decrease of 10% per one hundred additional feet/sec. at low speeds.

The results show that wind tunnel tests are easiest to make, are nearly as accurate as flight tests, and both flight and wind tunnel tests are 8% more accurate than model tests.

Engineering Highlights of A Century of Progress

By DONALD N. CHADWICK

THE manifold achievements of science, industry, and showmanship have been combined and presented to give to this World's Fair a living quality in its portrayal of man's progress. Primarily, the venture into visual education is of greatest importance. The magnitude of this effort has created a spectacle of industry and inventiveness that strikes a new note in the forward advance of mankind. It is the spectacular character of the exhibits and displays that provides the element of secondary importance in the mind of the visitor to the Century of Progress Exposition.

Photograph by Kaufmann-Fabry

View of Hall of Science.

The physical structure of the architecturally unique buildings forms an attractive setting for the housing of the exhibits themselves. The modernistic designs and combinations of colors arrest the attention of the observer by day, while the multi-colored lighting effects place him in a veritable fairyland by night. The completeness and rationality of the architectural plan of the exposition is indeed impressive. The general scheme of construction has brought forth as the basis of design a set of newly developed and lighter building materials. Upon this foundation it was necessary to produce new floorings, new metals, new finishes, new plastics, along with new methods of applying and utilizing these materials. The buildings themselves are practically windowless in construction, thus providing increased wall space, improved ventilating systems, and an opportunity for constant instead of

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variable lighting effects. They are of two or more stories, interconnected at both levels, and tied to the ground by broad, easy ramps. In this manner a more equal distribution of visitors throughout the exhibits is possible by providing them with a means of easy and comfortable movement. The design for utility was of immense importance inasmuch as neither space nor capital were unlimited in quantity. So it was that the buildings were planned to house the exhibits, rather than to merely form a setting for a group of non-uniformly distributed displays.

Color and light against a background of planes and surfaces form a brilliant symphony of irresistible appeal. To quote Joseph Urban, Director of Color for the Century of Progress, "The first large scale application of color in this country with an entirely new purpose, a new realization of its potentialities as an architectural medium, has been attempted at a Century of Progress Exposition. The problem was to coordinate and give vitality to a huge group of buildings of widely varying use and design and it became the function of color to unify the whole scheme and articulate it to the best advantage. But to achieve this effect the treatment of color as decoration superimposed upon the architectural form was inadequate. In this case, the effort was made rather to employ color as a positive force than as a trimming. In addition the special illumination at night had to be taken into account, and an endeavor was made to obtain the same values and create the same atmosphere under both day and night conditions."

The central stage for the presentation of the laws governing the basic sciences is set in the Hall of Science. For purposes of demonstration, science was divided into seven main divisions: astronomy, mathematics, physics, chemistry, biology, geology, and medicine, of which all but the first occupies a section of the Hall of Science. Adler Planetarium contains a remarkable display of great astronomical significance. Considered as a unit, the simplicity, cleverness, and fascination of the devices employed in the Hall of Science cannot fail to aid the visitor in better understanding the principles which they demonstrate. It is fitting to state that if the exhibits are studied with the thought in mind of their interconnection, much more will be gained than if they are considered as separate classes of phenomena, each representing a definite field of human endeavor.

Mathematics, the "Queen of the Sciences" has been divided into four major subdivisions for purposes of exhibit. They are: Numbers and Algebra; Geometry; Analysis; Applied Mathematics. The North Lobby of the Hall of Science contains a large octagonal prism, the hub of the mathematical section. Images of slides giving the progress made in the four subdivisions mentioned are projected from the inside onto the north, east, and west sides of the prism. The geometrical subdivision consists of a display of Pollock's models. Ever changing surfaces of light intersect string surfaces in motion. The effect of incandescent wires is produced by the resulting curves of intersection. D'Alembert's solution of a differential equation of wave motion forms part of the exhibit

showing the relation of mathematics to the development of radio. The application to Economics is shown in the presentation of the Law of Supply and Demand. Numerous other practical mathematical principles are illustrated by the use of instruments, diagrams, and models. The principles illustrated are, wherever possible, linked with the person who discovered or worked out the solution.

In arranging the ninety exhibits comprising the physics group in the Hall of Science a definite sequence was followed so that the visitor might obtain the same effect as that produced by a series of experimental lectures covering the most interesting and fundamental physical phenomena. They are arranged in the order of an ascending frequency scale, beginning at the one end with molecular physics and sound, thence upward through electrical frequencies to radio, light, X-rays, radium rays, and completing the scale with the highest frequencies known, those of the cosmic rays.

The first group deals with molecular physics, the expansion of gases and vapors, evaporation, refrigeration, surface tension and crystal structure. The second group explains the nature of sound, including musical sound and speech. The third group, beginning with a diorama of Franklin and his kite, shows magnetic effects and leads from the fundamental relations between electricity and magnetism to the dynamo, transformer and motor. Group four explains the vacuum tube and how it is used in radio. The fifth group shows many beautiful effects produced with light, demonstrating its nature and properties. Lastly, a group of exhibits contains various types of rays, including cathode, canal, X-rays, radium rays and cosmic rays.

The idea of a sequence of exhibits is carried out further by a large chart at one end of the main room of the Hall of Science. However, instead of being in terms of an ascending scale of frequency, it is in terms of the corresponding decreasing wave length scale. Aside from being theoretically instructive, the chart is ornamental, as well, since the values listed in proper order form a pleasing geometrical design.

Entering the great hall of the Hall of Science from the lake, or east side, the visitor is immediately impressed by an imposing model of the periodic table of the chemical elements which occupies one end of the hall. The central position and unusually striking design of this exhibit cause an immediate focussing of attention upon it. One of the most fundamental concepts of modern chemistry, the periodicity of the elements, is fittingly presented by this display which is itself 30 feet high and 25 feet in diameter. The lower part consists of a well designed and well proportioned model of a periodic table of the chemical elements, in which is displayed in proper sequence a sample of each of the elements. This visual presentation of each element is accompanied by an explanation of the most important source and the most important use of the element. Needless to say, the specimens and material for this exhibit have been collected from all over the world, and are in themselves objects of great rarity and beauty. A ten foot revolving globe surmounts the periodic table. On

this globe are indicated the locations of the most important sources of the more common elements. The very size and position of the globe serve to emphasize the fact that man's knowledge of the earth is limited to his acquaintance with the 92 elements exhibited below.

Chemical changes and the various ways in which they may be produced are contained in the first unit of the surrounding exhibits. The part played by catalytic agents in varying the speed of chemical reactions or changes is told. From here the visitor naturally goes to the unit on colloids. The suspension or dispersion of one substance in very finely divided form within another is made visible by a display of the Brownian movement. In the fourth unit is demonstrated the chemical treatment and refining of oil. The transformation of rubber from crude milky latex to the finished product may be watched in the fifth unit. The exhibit of most general interest in the chemical section is that dealing with the chemistry of food and nutrition. Here a 10 foot robot gives a 20 minute lecture on food chemistry and nutrition. He controls the processes of digestion within himself by means of moving pictures thrown on his side facing the audience.

Many of the world's foremost institutions are represented in the medical sciences exhibits. The displays and discussions have as their central subject the "Transparent Man". He is a transparent model of man, built in Dresden by the Deutsches Hygiene Museum, and illustrates with amazing clarity the skeletal, nervous, vascular, respiratory, digestive and muscular systems. No engineering construction feat employing steel or iron is any more remarkable than this heroic figure. The exhibit of the Wellcome Research Institution of England, to mention but one of the noteworthy sections of interest, commemorates the work of Sir Henry Wellcome, the American who was responsible for the conquest of yellow fever and other tropical diseases.

A direct connection is made between the Hall of Science and the Electrical Group to the east by means of a bridge over the lagoon. Approaching from the west the visitor feels the strength of the tie that unites these two. Three major buildings comprise the group which is 1,200 feet long and 300 feet wide. They are: Radio Hall; Communication Hall; and the Electrical Building proper. These buildings draw the visitor's attention, as do many of the other principal buildings within the Fair grounds, by their hanging gardens, steel cypress trees, electric cascades and fountains, gilded pylons and paved terraces. The Radio Hall, to the north, is the most complete scientific exhibit one may visit, because of radio's recent development and the fact that the exhibits are available for just such an exposition as this. Equipment used in the first radio attempts as well as that employed in television experimental work may be viewed in its entirety. Communication Hall, the middle building of the three, and connected to the others, is a source of interest because of the diversity of its exhibits. Here the visitor finds the various methods of wire communication explained to those who use such facilities every day. The telephone,

telegraph, stock ticker, and public address systems in their simplest and their most elaborate forms may be examined.

Farther to the south is the semi-circular Electrical Building. Here the generation, distribution and utilization of electric energy is portrayed in miniature by the exhibits of public utility companies and electrical manufacturers. Of course, the fundamentals of electricity are illustrated by attractive displays to be studied and gone over very carefully. In addition the visitor may examine electrical equipment for use in the home, office and on the farm; the application of electrical knowledge in the medical and dental professions; manufacturing and laboratory devices; and the many other fields in which electricity acts as an agent to furnish comfort, convenience and beauty to our everyday lives.

Before describing the exhibit to be found on the second floor of the Electrical Building, it is of interest to note that dioramas were developed for this exposition to such an extent that they have become a new art. The particular one under discussion in the Electrical Building is 92 feet long and is the largest ever made. Viewed from a distance of two or three feet the stage contains figures and objects modeled in correct size for the perspective. In the background great areas of mountain and plain are rendered, just as cities and factories might be. The illusion is perfected by the adaptation of moving lights to the scene. This diorama, featuring the central station exhibit, shows a high head water power plant at the foot of a mountain, a low head hydro plant farther down on the plain, and a steam station adjacent to a well populated city. The homes, manufacturing plants, and businesses of the city as well as the farms within the territory are fed by transmission lines through substations, forming an interconnected system of distribution. A spirit of vividness and animation is felt through the use of flowing water and other colored liquids, spinning turbines, and the movement effected by the employment of proper lighting.

The tower of history at the left of the main hall of the Electrical Building shows the progress of lighting, transportation, and industrial power. Three translucent cylinders are placed one above the other, the bottom one being 14 feet, the second 16½ feet, and the largest 19 feet in diameter. They are illuminated by lamps of 3,000, 5,000 and 10,000 watt capacity, respectively, and by means of an automatic switching device work in rotation. The first cylinder depicts the development of light from the candle to the electric lamp. The second silhouettes the old-fashioned locomotive, the horse car, the first trolley car, the earliest electric locomotive, the elevated steam locomotive, interurban cars and trolley buses. The topmost cylinder develops industrial power from the old fashioned water wheel through the stages of steam power to the modern steam turbine and electric motor. Numerous applications, both theoretical and actual of the use of electricity in industry, mining, and marine service are available to the visitor in this extremely fascinating building. As stated before, the educational value of these scientific developments is stressed throughout the various sections of the exhibits. Their part in promoting human

comfort, health, and general welfare becomes apparent to all.

The spirit of Thomas A. Edison as it is known to the world is exemplified by an exhibit of many of his fundamental discoveries and works in the Edison Memorial which adjoins the Electrical Group on the edge of the lagoon. The power and the spirit of pioneering and leadership which Edison displayed during his life are again magnified to the visitor.

The practical side of the electrical portion of the exposition is further understood if one considers the use of electricity within the Fair grounds. The Commonwealth Edison Company, which furnishes all the electrical energy for the Fair, has an investment of $176,000 in conduits, cables and substation equipment at the grounds. Two 12,000 volt cables are run from the Edison system to the substation at Soldier's Field. The additional supply comes from the 39th St. substation. Nine cables, of 4,000 volts each, on a three-wire, Y-connected system lead to the transformer vaults in the various buildings. A tenth cable of 4,000 volts reaches from the 39th St. substation to the Travel and Transport Group and thence to the north end of the Fair. The total rated capacity of the Soldier's Field substation is 30,000 kva.

The application of power is everywhere apparent to the visitor. From the Sky Ride to the Travel and Transport Building its application may be viewed. Mention of the Sky Ride brings forth the interesting fact that the principle of its structure and working mechanism has been put to practical use in England where it is used as a substitute for bridges over wide spans.

As the last major division to be considered herein, the visitor is required to journey to the Travel and Transport Building at the south end of the exposition grounds. Here he is struck by the design of the building. The exhibition space inside, 310 feet wide, has a circle 206 feet in diameter clear of any obstruction. The ceiling, 125 feet high, is covered by a dome which is hung by cables from 12 steel towers standing as sentinels pointing to the sky. Within the building are exposed to view numerous mural paintings and animated dioramas. As the keynote, the various methods of modern transportation are contrasted with the historical methods by means of actual vehicles. Two all-aluminum Pullman cars of the most modern type are adjacent to the first wooden sleeping car built. The latest type of multi-motored, all-metal low wing monoplane with a wing span of 75 feet, powered by two 550 hp. supercharged Wasp motors with a top speed of 186 M.P.H., looks down upon a stage coach used to carry mail and passengers through the Rocky Mountains a few generations ago. A Conestoga emigrant wagon, an old buggy, and the original box-kite type airplane are all neighbors on the floor of this remarkable building. To the south of the building are exhibited the premier train of Great Britain, the "Royal Scot", the Presidential train of the Republic of Mexico, as well as representative trains used in this country. A wealth of material is displayed by companies associated directly or indirectly with the automotive industry in both the Travel and Transport Building and in their own respective exhibits. Aviation presents its

own picture to view in showing the very comprehensive manner in which it has proceeded, step by step, to build itself up into one of our most important industries.

No attempt has been made in this article to discuss all the points of interest to the Century of Progress visitor who possesses an engineering turn of mind. Further, the symbolical interpretation of the Fair is dependent upon the individual, not upon the magnitude nor extent of the exhibits he views. However, it seems certain that the link connecting the basic sciences with progress has been strengthened many times as a result of the exposition. The observant visitor cannot help but be stimulated and experience a new point of view after having met science face to face.

Suggestions for the Student Engineer

By R. M. HENDERSON

EVERY student entering college is faced with the fundamental decision as to which branch of engineering he will elect, and as a secondary decision he must subsequently decide the extent to which he desires to specialize.

In some cases he will have made the first decision before he enters but in a great many others the decision is not made until the end of the freshman year.

What are the real reasons which impel a man to decide on an engineering education? Is it because he has a clearly defined bent in that direction? Is it because he or his father thinks that an engineering training is a good foundation regardless of what field subsequently may be followed? Is it because as a boy he was always making things and appeared to have mechanical ability or genius in the eyes of fond parents?

One of these is the usual reason, but a study of the subsequent occupations of engineering graduates inevitably raises the presumption that in very many cases the selection of the particular course was made without sufficient thought, with a consequent penalizing of progress in after years. Of what particular benefit is an engineering education to a man who finds himself in his father's business of merchandising cigars? There is such a man within the writer's acquaintance. He was a good student and would probably have made a success along engineering lines, but some other form of education presumably would have been of more benefit. There are many for whom an engineering education is very largely or entirely wasted so far as the technical field is concerned, or the type of engineering education proves to have severe limitation for the career actually followed even though along technical lines.

As an illustration, recent statistics indicate that 75% of all engineering graduates in this country have reached administrative

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or executive responsibility by the age of 45 to 50, and a considerable percentage are detached from technical problems either wholly or in large measure. It, therefore, is a natural question and perhaps may be a very important one, to inquire into the character of the technical training that is to prepare the engineer for advancement beyond the purely technical field that is apt to be the only consideration at the time the freshman must make his decision.

Some, educated in one particular branch of engineering, find themselves working out the future in an entirely different branch. About the year 1900 electrical engineering was much in the public eye and the decision to enter a student in that branch was, in many instances, dictated solely by the belief that the electrical field was going to offer more opportunity in the next 20 years than any other branch of engineering. As a result, men who had no particular qualifications for electrical rather than for some other branch of engineering, are found today regretting the time they spent in specializing along electrical lines, because they have done very little in the electrical field and have had to do much outside night study to fit themselves for other technical subjects which they subsequently faced.

Recognizing these difficulties in after life, engineering colleges have endeavored to meet them by providing more general courses while still maintaining the highly specialized basic courses. In those engineering schools which are associated with universities, efforts have been made to find a means of tying together the engineering school with the school of commerce and other departments of the university. Some years ago at Lehigh, a course leading to the degree of industrial engineer was laid down to cover a five year period to fit a man to become an executive in industry. The graduate in that course was expected to be able intelligently to follow the discussions of structural design, machinery layouts, steam, hydro and internal combustion engine power, factory management, finances, metallurgy, chemical engineering, mechanical, electrical, and civil engineering. The obvious intent was to provide a foundation on which to build a career as an industrial executive who should be suitably qualified to administer such various technical branches as might come under his eye. There is considerable difference of opinion as to the practical workings of this course.

Recently at Cornell, a course has been offered leading to the degrees of B. S. in Administrative Engineering, which can be followed by a fifth year bringing the degree of Bachelor of Science in any of the other basic branch of engineering.

The new Armour Plan is perhaps the most advanced effort in this direction in its inclusion of a four year basic science course, which may be followed by one or more years of graduate work leading to various advanced degrees and providing a considerable amount of business and cultural subjects.

These examples point to the effort that is being made to meet the objections of the older graduates who find themselves handicapped in broader fields of activity by the limitations attending a too highly technical foundation. The possibility of meeting

this situation in a four year course has been seriously questioned and there are many who believe that it will require five or six years to do the job well. Objections have been raised to all attempts to do the bigger job in four years on the score that the training is not sufficiently thorough in any technical subject to provide an adequate grounding, and the objectors urge that a better plan is first to pursue one of the basic branches such as mechanical, electrical, chemical, or civil engineering and thus provide a sound engineering foundation on which to add a business superstructure.

Certain colleges have become known for their work in specific fields. It is claimed that 75% of the steel made in the U. S. is produced under the direction of men coming from one college; another school developed a name in railway engineering; at least two are outstanding in mining engineering. It is clear that if a man has a definite reason for pursuing a certain field of study, there is no great difficulty in reaching a decision as to the school to be selected or as to the branch of engineering to be followed, and to such a man there is no particular interest in the comments here given. If a man is foreordained to be a steel maker or to follow in his father's business, he may specialize along such line with excellent chance that it is the best answer, but the average man who enters an engineering college has no way of knowing what he will be doing 10 or 20 years later. Such men can well consider the wisdom of avoiding excessive specialization in one branch of engineering.

In the strictly engineering college, as distinguished from the engineering school in a university, there appears to be a rather different attitude toward the business and cultural subjects and the so-called humanities, from that found in the institutions which offer a wider range of training. This attitude in the engineering school crystallizes into a resentment on the part of students toward any subject not clearly related to engineering. The disposition is to disdain such subjects as English, Economics, Psychology, Modern Languages, Elocution, Public Speaking, History and the like, and yet it is a common complaint that the average engineer or architect is a poor business man, that he cannot write good letters, and that his reports are involved and difficult to follow. The ability to use the English language clearly, concisely, logically, and forcefully ought to be a natural attribute of a trained engineering mind, but it nevertheless is painfully absent in too many engineers. The writer recalls an unhappy six months following his entry into an organization largely manned by university men of engineering training, because he was unable to write letters that would pass the censorship of the executive officers who had to sign them. There was never a more intensive job than the writer's application to the business of finding how to write business English that would pass the scrutiny of those able executives. The chagrin with which he reread a letter sent back to him and torn half way down the sheet is one of his most poignant recollections, but it was an invaluable experience.

In several large consulting engineering organizations, reports prepared by various members of the staff are invariably passed through the hands of one or more censors

whose primary objective is to edit the language used. The president of one nationally known engineering company took his personal time to rewrite a two page letter, summarizing an important report to a great banking house, to reduce it to three quarters of a page, in which everything in the longer letter was said in more effective form.

It is a bitter commentary that the responsibility for negotiations for large purchases of machinery and other technical requirements is often taken out of the hands of the engineer because he is a "poor trader". He is unable to conceal his true and honest preference from the more shrewd salesman who knows he is in a preferred position and takes advantage of that knowledge to exact a higher price than he would gladly accept in a trade with an equally shrewd buyer. Thus the engineer is allowed only to write the specifications and make his technical recommendations to a "business man" who conducts the financial side of the transaction. Perhaps this is inevitable and will continue as long as engineers are constituted as they are, but there is good reason to believe that this limitation is susceptible of satisfactory correction by better attention to the business training of the engineer. He should be just as capable of acquiring business judgment and sagacity as he is of achieving competence in the theory and practice of his profession. It has been said with some plausibility that shrewdness is an attribute that is born in a man and that it is not commonly acquired later, but there are many belated financial successes among engineers that can be offered to refute that belief. Certainly the engineer need not accept the verdict that he is barred from business success as long as he has the intelligence to become a sound practical engineer.

The engineer who comes anywhere near reaching the mark of his ambition becomes a man of some standing and importance in his community. One of the principal functions of government, whether municipal, state, or national, is to carry out the program of building up our physical domain. Every engineer should be actively interested in the public works program proposed by any unit of government in which he has a vote and he should contribute his technical knowledge for the benefit of his lay neighbors to enable them more intelligently to pass on bond issues and appropriation measures involving sound engineering and business judgment as a fundamental. He therefore limits his field of usefulness to his community if he is unable to speak and write in an effective manner. As he gains experience, he enlarges his opportunity for advancement and for general usefulness to society, in which he can only be a real factor if he can participate in discussions of many subjects other than those pertaining to "shop".

An important reason why the legal profession has developed so many leaders in the conduct of our public affairs is the attention given to public speaking and writing for publication. There is every reason why engineers should equally lead in the conduct of our great corporations and our government. There is no insurmountable reason why they cannot become equally effective in debate; in knowledge

of the theory of government; in judging far better than the lay or legal mind the wisdom of many proposed laws; in dictating financial policies of industrial companies or great business corporations; in applying the test of sound business judgment to appropriations and proposed bond issues for public improvements; and perhaps most important of all in learning to understand human nature as it must be understood to achieve a full measure of success in dealing with people in the mass. This last is equally necessary for success in any large sense in their private or public life.

One of the embarrassments of the engineer in attempting to broaden his culture and therefore his usefulness to society is the fact that the curriculum of the engineering college of the present period actually requires about 50% more clock hours per year than is required by any other professional or general course of education. This fact forces the engineering student to greater effort to cover the bare requirements of his education than is necessary for his legal or medical brother. He naturally feels that the technical subjects are of basic importance and in the undergraduate period of his life he is unable to realize what his problem will be in 10 or 20 years; thus with entirely inadequate reasons he elects a particular branch in engineering or a particular type of training and subsequently finds that many valuable hours of effort were spent on subjects which have proven to be of little value in his after years.

As before stated, there has been a definite awakening to the shortcomings of engineering education as viewed by the engineer of 50 years of age who has become a responsible business executive or a high public official. It has caused many attempts to broaden the training by cutting into the four year "standard" courses with more business and cultural subjects; by advocating a longer period such as five or six years in which the engineering school follows three years of academic work after the manner of the law and medical schools. Some tie between the university and the technical college is persistently urged and sought. There is a wide divergence of opinion except on one point—some way must be found to meet the requirements of the 75% of engineers who outgrow the relatively narrow limits of the professional side of life. It is not intended to offer the solution in this article—indeed there is no generally accepted solution as yet. Courses of more than four years are open and it is largely an individual matter to decide, on the basis of purpose and limitation of time or money, how to start. Later, circumstances may help to crystallize their decisions. The depression has solved the question for some and may even turn the trend from a four year to a five year course.

When jobs could not be found by the graduates of June, 1930, many who could manage it returned for a post graduate year. In 1931 those men had the preference for such jobs as were open, with the result that an increasing proportion of 1931 graduates returned for a year of graduate work. Some of them took business administration for one or two years. There is a cumulative effect that will not subside until the country returns to a degree of prosperity such that jobs are wait-

ing for practically all of the graduates of the four year courses. By that time the demonstrated value of the extra one or two years' training may have changed the whole trend of thought with respect to the best type of training for the majority of students.

These thoughts are directed not only to the entering student, but to those who may have the opportunity to offer advice to some young man who is about to spend four or more years of his life within the walls of an engineering college. Four years in college, as a minimum, is usually followed by two or three years at work before the engineering graduate begins to climb appreciably. Thus it may be said that seven or eight years is devoted to specialized preparation for a subsequent period of not over 40 years of active business life. In eight years of preparation for 40 years of work, every hour that is devoted to more or less useless effort is taking something out of the effectiveness of the 40 years of later work. It therefore is a matter of vital importance to discover or analyze the reasons for entering an engineering college and to elect a program that will minimize waste effort as far as possible.

Reflection on the thoughts here presented may not contribute to the simplification of the problem of selecting a course but it may modify the views on the value of specialization and on the need for more thought about the time 20 years after graduation when the job in hand or the next job head will require a many sided man for the work.

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

The Principles of Optics

By Arthur C. Hardy and Fred H. Perrin
McGraw, $6.00

WHILE the study of optics can be split up into two well defined classes, namely, pure optics which deals with the subject from a mathematical standpoint and applied optics which is devoted to the design of optical instruments, this book makes no distinction between these two headings and attempts to steer a middle course as a means of presenting the subject both thoroughly and broadly.

The book is designed for those who possess the general knowledge of optics as given in the average college physics course. It should be of value to the person who intends to make optics his career and to the person who is interested in the subject but does not intend to specialize in the particular field. The author hints that we may soon find a new profession of optical engineering coming into importance.

The first five chapters of the book deal with the geometrical theory of image formation. The phenomenon of diffraction, radiation and light sources and their detection by means of the eye, photographic plate, and photoelectric cell, the properties and construction of optical materials and parts, and optical instruments such as spectacles, photographic objectives, telescopes, microscopes, and projection systems are subjects which are treated in detail.

Architectural Acoustics

By Verne O. Knudsen
Wiley, $6.50

IT HAS not been until the past few years that architects have considered the designing of buildings in a way to please the ear as well as the eye. Hitherto our so-called architectural masterpieces have been wonderful in the light of beautiful designs and artistry, but they have been sorely lacking in acoustical perfection. So little was known about construction in regard to the latter that the designer had to wait until the building was finished before he could tell whether a speech would be plainly audible or a mere jumble of echoes and reverberations. The subject of acoustics has now become a science, and it is as such that Mr. Knudsen treats it.

The book is divided into three main parts. The first deals with the elementary principles of sound and its transmission. The second division describes various materials and their sound absorbing and reflectory qualities, with tables giving numerically these qualities. The third part tells how these materials can be adapted to the various types of buildings, such as auditoriums, music rooms, theatres, broadcasting studios, and residences.

"Architectural Acoustics" is at once a textbook and a reference book. The volume contains numerous tables and illustrations and is very instructive.

THE ARMOUR ENGINEER

Student Technical Publication of Armour Institute of Technology

VOLUME XXV | NOVEMBER, 1933 | NUMBER 1

A Silver Anniversary

WITH this issue of *The Armour Engineer* the publication begins its twenty-fifth year of existence at Armour. This lapse of time has seen many changes and constant improvement in the content and make-up of the magazine. During this time the continuous aim has been for the benefit of the readers. The changes which have taken place have been made for the express purpose of presenting not only a well balanced engineering college publication, but a magazine which will be of interest to the subscribers.

The Armour Engineer is a student publication, and as such the editorial staff welcomes any criticism which tends for the improvement of the magazine. This staff

also invites men who are interested in such work to participate in the publication. Let us hope that the progress made in the first twenty-five years will be an incentive to greater achievements for the next quarter century, with the result that *The Armour Engineer* will maintain the high standard it has always enjoyed.

Tact

MR. CHARLES F. KETTERING, noted inventor, once made the remark, "Research is just about 10 percent experiment and 90 percent knowing how to get along with the fellow you're working with." Not only in research is this true, but in every walk of life. The acquisition of tact in dealing with fellow men can never be overemphasized.

Engineers, in general, are forced not only to deal with their fellow men, but to be in charge of them. Maximum cooperation and loyalty cannot be obtained from those under your supervision unless they are handled with tact. The acquisition of this virtue is best obtained by observing the actions of men who have the handling of men, and, equally important, by constantly mingling with people, observing their likes and dislikes, learning to converse freely and intelligently, and, above all, obtaining the ability to fraternize with members of all classes.

THE GUEST EDITORIAL

Learning and Education

LEARNING, in itself, is of no value to society. It becomes useful only as it is applied to the problems of life. So, a real education must comprise not only the acquisition of learning but, even more important, the acquisition of the faculty of using that learning.

Learning is stored water; it becomes useful only when released. This stored energy must later be released through canals, turbines and transmission lines. On your choice of these and the effectiveness of your use of them will depend your success.

Success is possible without education, but incomplete. I have known men of great natural ability to be brought to a standstill at a point whence education would have enabled them to continue to greater heights.

Centuries ago ambitious men studied the arts of war. Today they must study the arts of peace. But in peace, as in war, the leader must be a trained man who has both learning and the ability to use it.

—Sterling Morton
Secretary and Director
Morton Salt Company.

THE COLLEGE CHRONICLE

NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Swimming

THROUGH the combined efforts of Roy Carlstrom, '33, last year's captain, and other members of last year's swimming team, swimming has become a major sport at Armour. Under the able leadership of Captain Irving Kolve and Manager R. W. Suman a very successful season is anticipated.

Due to increased interest in the sport a large number of Freshmen and upperclassmen are expected to try out for this year's swimming team. Since only two men of last year's squad have been lost thru graduation, Carlstrom and Giovan, plenty of material will be available.

At present plans are being made for the coming season and the University of Chicago pool will be open soon to Armour swimmers.

Photograph by Bard

Presenting Armour's captains. Left to right: Talaber, wrestling; Kolve, swimming; Nelson, track; Pflum, basketball; Omiecinski, baseball.

Basketball

DUE to the loss of only one regular by graduation the Techawk is expected to be a formidable bird on the cage court this season. While Beemsterboer, last year's captain, has graduated, it appears that the current edition of the Engineer quintet will be able to compensate the loss of the former center by the concentration of more power at the other positions. This is claimed after scanning over the list of veterans who are expected to carry the tri-color to new peaks on the hardwood.

Heading the list of "A" men are Captain Pflum, Lauchiskis, Dollenmaier, Warner, Lukas, and Rummel, and to top off this brilliant array we find that Christoph, a regular during the 1931-2 campaign, but out of school last season, is back again. If Christoph, who appears to be a gifted player, can fit into the picture with other "naturals" such as Pflum and Lauchiskis, the Engineers should certainly better their last year's record which hovered around the .500 mark.

Despite the fact that these men who have been mentioned appear to have the inside track to varsity positions at the moment, do not be surprised to see one or two of them riding the bench due to the

exploits of some rookie freshman. One may recall that last year's frosh produced three capable basketeers in Dollenmaier, Warner, and Laschober and there may be still more in this term's "pack o' green."

Coach Krafft is again taking over the reins as head coach after relinquishing them to Otto Kuehn for one season due to illness. Now that the former is in the proverbial pink, he is expected to throw all of his energies into building up another great five for Armour.

Boxing and Wrestling

TECHAWK hopes in boxing are high this year due to a large number of new men interested in boxing and the return of the veterans from last year's team. Coach Weissman feels confident that he can turn out a team of smart boxers, and he only hopes that the difficulty in arranging a shedule can be avoided this year. A squad built around such men as Capt. McDonald, Marcus, Bacci, Breh, Norris and Ruben, managed by James Castanes surely can meet any foe without the least bit of worry. Tentative dates have already been set with Loyola, Northwestern, Chicago, St. Viators, Culver and several Y. M. C. A.'s in Chicago. The dates are all to follow the annual boxing tournament which will be held shortly after Thanksgiving. A fast set of meets has been planned as home bouts to give Armour fans a chance to see their men in action.

Wrestling at Armour has gained in prominence to the degree that it has become a separate team from the boxing team. B. B. Weissman, Coach, Frank Talaber, Captain, and F. Koko, Manager, see a bright season ahead with the return of a full team of regulars and a strong supply of new material.

Track

ALTHOUGH the regular indoor track season will not start until after the Christmas holidays, much enthusiasm is expected to be displayed over the annual interclass meet to be held in the University of Chicago's field house immediately following the mid-winter recess. Manager Kuehn and Captain Nelson are contemplating a stiff schedule for the Engineers which will call for meets with some of the leading colleges and universities of the Middle West.

Tau Beta Pi

TAU Beta Pi, honorary engineering fraternity, initiated the following men on Thursday, October 12, at the Knickerbocker Hotel prior to the opening of the national convention at the hotel.

L. J. McDonald, M. E. '34.
H. Kreisman, M. E. '34.
R. J. Pflum, C. E. '34.
R. A. Fleissner, C. E. '34.
N. H. Kuehn, C. E. '34.
S. G. Lehmann, E. E. '34.
E. G. Lundin, E. E. '34.
R. D. Armsbury, Ch. E. '35.
J. J. Ahern, F. P. E. '35.

Five well-known faculty members, Professors Heald, Paul, Peebles, Finnegan,

and Spears, took entire charge of the initiation ceremonies. Most of Friday afternoon and evening was spent in visiting the Century of Progress Exposition and on Saturday evening the grand banquet was held. Illinois Beta chapter, at Armour, acted as hosts to the convention, as in 1916.

Pi Tau Sigma

THE honorary mechanical engineering fraternity initiated the following men on October 18.

R. Stahl, '34.
W. Hensel, '34.
C. Johnson, '34.
J. Manly, '34.
J. DeBoo, '35.
R. Maci, '35.

On October 20 and 21 the Armour chapter appeared in the role of host to the annual convention of the society. While attending the conclave, the delegates also visited the World's Fair.

Chi Epsilon

CHI Epsilon, honorary civil engineering fraternity, plans to announce its pledge list sometime during the next few weeks. At a meeting held last May the following men were elected and installed as officers of the society:

President	J. E. Schreiner
Vice-President	N. H. Kuehn
Secretary	C. L. Shermer
Treasurer	G. A. Nelson

G. T. Korink was elected as editor of the *Transit,* official news organ of the fraternity.

Phi Lambda Upsilon

ARMOUR'S honorary chemical engineering fraternity has the following officers for the year:

President	W. E. Gunderson
Vice President	R. W. Marty
Secretary	F. C. Noerenberg
Treasurer	W. J. Bentley
Alumni Secretary	K. Eberly

A number of meetings are planned for the future and some interesting speakers have been invited to give lectures. A smoker is to be held in the near future.

Eta Kappa Nu

ETA KAPPA NU, national honorary electrical engineering fraternity, pledged the following men Friday, October 6, in the fraternity rooms.

Glen F. Graham, '34.
William W. Laemmer, '34.
Elmer G. Lundin, '34.
Thomas F. Murphy, '34.
John Paslawski, '34.
William B. Ahern, '35.
Arling M. Wolf, '35.
Donald E. Young, '35.

The active members are President Paul Thompson and Stephen Tehrmann.

The National Eta Kappa Nu convention was held in Chicago, October 20 and 21. Dr. Hotchkiss was one of the principal speakers at this convention.

Salamander

SALAMANDER, honorary fire protection engineering fraternity, pledged two men, Charles P. Kuffel, '34, and Edwin N. Searl, '35, at a meeting held Friday, October 6, in the fraternity rooms. Each

pledge will write a thesis on a subject dealing with fire insurance or fire protection before initiation takes place.

The officers of Salamander for the year 1933-1934 are C. A. Cunningham, president; G. E. Myers, vice-president; and A. J. Anderson, secretary-treasurer.

Scarab

EDFOU TEMPLE of Scarab, began a busy season as host for the Scarab convention held in Chicago, October 15, 16, and 17 at the Architects' Club. President W. E. Hotchkiss was one of the speakers. An enjoyable time was had by showing the delegates the town.

The officers for the season are:

President..........Roy Ekroth
Vice President..........B. Buchhauser
Secretary..........R. Tague
Treasurer..........L. Davidson
Sergeant-at-Arms..........R. Schwab

Pledging is to be held in the near future.

Honor "A" Society

ARMOUR'S honor athletic society, Honor "A", begins the current season with the following newly elected officers:

President..........Leonard G. Rummel
Vice President..........Irving Kolve
Secretary and Treasurer......John Ahern

New members will be initiated into Honor A at the Society's banquet following the annual Varsity-Alumni basketball game. Members of Honor A are chosen from the outstanding lettermen of the school.

American Society of Mechanical Engineers

ALTHOUGH the Armour branch of the American Society of Mechanical Engineers has been a member of the national society in name only, plans are now under consideration whereby the local branch will officially join the national society. It is recognized that such a move will result in a direct advantage for both practicing and prospective mechanical engineers.

At the meeting on October 6, Professors Peebles and Roesch explained the activities of the society and the benefits to be derived therefrom. The prospective members were also told of the need of professional men being members of their respective societies and associations so as to promote better business contacts. Professor Nachman also spoke.

American Institute of Electrical Engineers

TALKING pictures shown by the Illinois Bell Telephone Company on the subject of "The Development of Sound Pictures and Their Use" was the feature of the meeting of the Armour chapter of the A. I. E. E. held Friday, October 27.

At the first meeting of the year of A. I. E. E., October 7, tentative plans for the coming year were discussed. President S. G. Lehmann appointed the following committees at that time: Program Committee —D. Chadwick, R. L. Friede, and W. W. Laemmer; Membership Committee — C. Clarkson, F. A. Cullen, G. F. Graham, F. Henke, J. C. Tamney, and D. C. Young.

Fire Protection Engineering Society

CHIEF McAULIFFE, of the Chicago Fire Insurance Patrol, spoke on "The Insurance Patrol and Its Functions" at the regular meeting of the Fire Protection Engineering Society, Friday morning, October 20. Chief McAuliffe is nationally known in the field of fire protection and is largely responsible for the success of the Insurance Patrol.

On September 29 Mr. Frank Erion, one of the foremost adjusters in the country spoke on "Adjustment of Fire Losses." He told of several of his many interesting experiences in this work.

Alpha Chi Sigma

ALPHA CHI SIGMA, professional chemical fraternity begins the current season with the following officers:

Master Alchemist......W. E. Gunderson
Vice Master Alchemist......J. R. Lange
Recorder..........R. McFarland
Secretary..........R. W. Marty
Treasurer..........D. J. Mullane
Alumni Secretary.........J. J. Doheny, Jr.

A rush smoker was held on October 20 at the Delta Tau Delta house and all those present had a very pleasant evening.

Armour Architectural Society

R. ESBENSEN, Massier and Sous-Massier of the A. A. S. predicts a very successful season. At a meeting held early in the semester plans for a dance for the purpose of bringing upper and lower classmen into closer contact were formulated.

American Institute of Chemical Engineers

ARMOUR branch of the A. I. Ch. E. begins this year with the following officers:

President..........R. McFarland
Vice President..........J. Humiston
Secretary..........R. C. Miller
Treasurer..........A. Kapecki

The speakers' committee has been trying to obtain several chemical engineers to speak at the meetings which are to be held soon. Because several of the officers worked outside of school the A. I. Ch. E. was a little late in getting started, but now the men have more time to spare and things are fast getting under way.

Western Society of Engineers

AT their first meeting of the current semester on October 6, the Western Society of Engineers had as its speaker Dean Penn, who talked on the Reclamation of the Netherlands. Due to his long experience in the civil engineering field, Dean Penn was especially suited to speak to a group of prospective engineers in describing the land of the Zuider Zee. The dean, who used a projection lantern to give a more vivid picture of the terrain of the country, is a native of the Netherlands.

On October 20 the society was scheduled to have as its speaker Mr. D. Rush of the R. W. Hunt Company of Chicago. Mr. Rush was to speak on the manufacturing of concrete and methods of reinforcing with steel bars. The society plans to have many other prominent speakers during the semester.

ALUMNI NOTES

NEWS OF ARMOUR ALUMNI ASSOCIATION AND OF ARMOUR GRADUATES

Jacob M. Spitzglass

JACOB M. SPITZGLASS, one of the loyal of Armour alumni, died early in October, after an illness which had kept him in the Michael Reese hospital for more than a month. Mr. Spitzglass graduated from Armour in 1909, and was Vice-president in charge of research for the Republic Flow Meters Company of Chicago.

A native of Russia, Mr. Spitzglass came to this country in 1904, and entered the mechanical engineering department of Armour Institute. After his graduation, he was active in developing an electric meter to measure the flow of fluids in pipes, and was associated with Mr. Cunningham, Chairman of the Armour Board of Trustees and President of the Republic Flow Meters Co., and Professor Gebhardt of Armour Institute in the enterprise which later became the Republic Flow Meters Company.

Always active in research, Mr. Spitzglass developed several slide rules which are in wide use today. He was a brilliant student, and was always particularly interested in mathematics. His educational ambitions were not easy to realize—he was over thirty when he entered Armour—but he remained an eager student all of his life.

It was Mr. Spitzglass' research which first developed the gas heater for homes now being made by the Autogas Corporation. He was awarded the Edward Gongatreth medal for his inventions.

Mr. Spitzglass remained a staunch Armour supporter throughout his career. He contributed generously to Alumni funds and was always eager to assist or advise an Armour man. He was a regular visitor to all alumni gatherings.

He is survived by Mrs. Spitzglass and two sons.

Employment News

REPORTS from the Placement Office at Armour Institute indicate that the chilly world into which the engineering graduates have been thrust for the last three years is beginning to thaw. The records show that September and October placements were considerably higher than in any of the eight preceding months.

Particular activity during the last sixty days has been noticeable in the electrical engineering field. International Business Machines, Zenith Radio, Stewart-Warner, Grigsby-Grunow, and Westinghouse Electric have made additions to their technical staffs with the result that few graduates of the electrical department at Armour remain inactive.

Other branches of the engineering profession, while lagging behind the electrical

field are moving more actively than they were during the spring and summer.

Altogether, since the opening of the Placement Office at the first of this year, three hundred and thirty men have been placed in positions of one kind or another. Many of these were employed only temporarily at the Century of Progress exposition. Seventy men, however, have been placed in permanent engineering positions where training and capability will insure them steady advancement in the future.

Alumni who are not employed or who are employed only temporarily at present are urged to drop in at the Placement Office at the Institute and file an application.

A PLEA has been issued that alumni still owing money on their pledges cooperate as much as possible toward their fulfillment. Alumni joined with the students and faculty last year in a Promotional Fund Program to raise $60,000. The alumni share in this fund was $40,000 and the pledges for the sum were secured. To date $26,000 has been paid, but there remains a balance of approximately $14,000 outstanding on alumni pledges. These funds are sorely needed as bills totaling $9,925 remain unpaid, it was stated.

Mr. George S. Allison, Secretary-Treasurer of Armour Institute of Technology, has extended his personal cooperation and the facilities of his office in collecting the pledges still due.

Personals

John W. Hurley, '30, who, after studying aeronautics in connection with the civil engineering course, passed the naval examinations and spent a couple of years flying with the High Hat Squadron on the Pacific Coast and in Hawaii. He is now a co-pilot on the United Airways' Chicago-Cleveland-New York flight.

E. Percy Boynton, '30, has carried out his intention of combining law and engineering in view of doing patent work. While working for the Union Carbide and Carbon Co., he studied law in the evening and was admitted to the bar in New York City last spring.

Philip F. Miller, '11, with the De Laval Separator Co., New York, passed away March 29, 1933.

Paul B. Hultgren, '25, was married to Miss Ruth Topic of Chicago on Aug. 19, 1933.

Roy N. Towl, student in the Civil Engineering Department of Armour from November 1901 to February 1903, has recently been elected mayor of the City of Omaha, Nebraska.

George Von Gehr, '28, member of the Bar, is now associated with Langner, Parry, Card, and Langner, International Patent Solicitors. Mr. Von Gehr was married last spring.

Fred C. Dierking, C. E., '12, is with the Chicago Packard Company. Fred prepared an unique booklet on Packard cars which is being used by Packard dealers throughout the country.

Bill Buehne, '33, was married this summer to Miss Florence McGuffie in New York. Bill is now residing there and working for the General Electric Co.

L. L. Swartz, E. E., '24, is the proud father of a baby girl.

Harry Rogers, '10, is with the Rock County Sugar Co., and lives in Janesville, Wisconsin.

M. P. Venema, Ch. E., '32, is working in a Dental Lab., applying plastics to Mechanical Dentistry.

H. W. Bodinson, '33, and E. C. Kenner, '33, are employed at the Kentucky and Illinois Actuarial Bureau, respectively.

D. M. Fetterman, E. E., '31, is working at the Clarion Radio Corp.

Rog. Waindle, M. E., '32, is working in the Maintenance Dept. of Wright and Ditson Co.

G. Berglund, F. P. E., '33, is working in Chicago at the Underwriters' Lab.

V. C. Alexander, C. E., '33, is working at the Swift's Stock Yards.

TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF AUTHORS AND PUBLISHERS

Metering Air by Psychrometry

By Donald B. Knight

(From Refrigeration Engineering, April, 1933)

THE usual methods employed for determining air flows consist of the anemometer, the Pitot tube, and the Thomas meter.

The anemometer, which in the last analysis turns out to be a windmill, is notoriously inaccurate, but due to its facility, it is very popular just the same. We are told that the Pitot tube can get pretty good results, but it appears that one must be very well trained in the subtle nature of air and Pitot tubes before he ventures to make use of the instrument. The Thomas electric meter is an arrangement inserted in the air stream consisting of a duct about twice the diameter of the mouth of the blower and containing resistance wire webbed across the diameter. Thermo-couples are placed on both sides of the web and the air is heated in passing over wires by means of a carefully measured electric current. The volume of air passing is, of course, discovered from the temperature before and after heating and from the amount of heat applied. This is naturally an accurate instrument but also a fussy one, and it has the same disadvantage that both the anemometer and Pitot tube possess of adding resistance to the flow of air.

The method devised by Mr. Donald B. Knight, which has been employed very successfully thus far, consists in passing steam into the air entering the system and measuring the increase in the partial pressure of water vapor at the outlet.

A measured quantity of water is placed in a suitable boiler which is heated at a constant rate. The steam is led to the air inlet by a tube from the top of the boiler. The time of steam delivery is measured and the wet and dry bulb temperatures at air inlet and outlet are observed during the steam delivery. The mol fraction of water vapor in the air is obtained from the wet and dry bulb temperatures by consulting a psychrometric chart.

At the end of a prescribed interval of time the boiling is discontinued and the quantity of water remaining in the boiler is measured.

The mols of air circulated per mol of steam added is arrived at by the following formula:

$$\frac{1 - X_o}{X_o - X_i} = Y_g$$

where X_o is the mol fraction at the outlet, X_i is the mol fraction at the inlet and Y_g is the mols of air circulated per mol of steam added.

It follows from the above that Y_g multiplied by the mols of steam added in a given length of time gives the number of mols of air circulated in the given length of time which is readily calculated in cu. ft. per min.

Before making the measurements it is of course necessary to assure oneself that no moisture is lurking within the system by taking wet and dry bulb readings at the inlet and outlet and noting that the two pressures of water vapor coincide upon the psychrometric chart.

The formula for Y_g is derived as follows: the water vapor pressure in the inlet air, measured in inches of mercury and divided by the total atmospheric pressure of 29.92 in. Hg is equal to the mol fraction of water vapor in the inlet air according to Dalton's law of partial pressures. The mol fraction of the outlet air is similarly determined. The symbol Y_g denotes the number of mols of air entering the system for every mol of vapor added so that X_iY_g is the number of mols of vapor contained in the dry air, and $X_iY_g + 1$ is the total number of mols of water vapor leaving at the outlet of the system. But $X_o(Y_g + 1)$ is also equal to this quantity and the equation may be written:

$$X_iY_g + 1 = X_o(Y_g + 1)$$

$$Y_g(X_o - X_i) = 1 - X_o$$

$$Y_g = \frac{1 - X_o}{X_o - X_i}$$

Dynamic Braking

(From Power Plant Engineering, September, 1933)

STORED up mechanical energy in a rotating electric motor can be converted into heat either directly or indirectly by a friction brake or by first converting it into electricity and then into heat in an external resistor. Either method brings the motor to a stop, but the latter method, called dynamic braking, does it with less wear and tear on the apparatus.

Dynamic braking is applied most commonly to shunt-wound or compound-wound direct-current motors. In the case of the direct-current motor, braking is secured by first disconnecting the motor from the power supply and then connecting it to an external resistor circuit. The counter e.m.f. or voltage generated in the motor armature by its rotation in the magnetic field produces a current in the resistor circuit. This current reacts with the magnetic field of the motor in such a direction as to produce a retarding torque. The energy delivered into the circuit appears as heat in the resistor. The direction of the counter e.m.f. is opposed to that of the line voltage. Therefore, the braking current is in a direction opposite to that of the current when the motor is delivering power and should not pass through the series field. If this current were allowed to flow through the series field, it would produce a magnetic effect opposing that of the shunt field, weaken the total field of the motor, and result in reduced braking torque. In some cases the result would be an entire loss of torque if the series field strength was equal to that of the shunt field.

It is common practice to design the braking resistor to permit approximately full-load motor current to flow at the instant braking begins. The value of this resistor is determined by Ohm's Law. The counter voltage of the armature is approximately the same as the line voltage; the current value may be obtained from the name-plate reading of the motor. The energy loss is expressed by the formula

E^2/R and therefore determines the capacity of the braking resistor.

As the name implies, dynamic braking is effective only while the motor is moving. It can be used therefore to stop the motor but not to hold it after it has stopped. For this latter purpose additional mechanical brakes are necessary.

Heat Insulation for Steam Plants

By A. Lindsay Foster

(From Blast Furnace and Steel Plant, August, 1933)

THE practice of heat insulation for steam plant remained more or less static for many years after the introduction and acceptance of magnesia, which established itself on its known composition, and which, when unadulterated and properly applied, gives a large measure of assurance as to its non-conducting properties in use.

The mixture of 85 per cent magnesium carbonate and 15 per cent asbestos became, and was for many years, virtually a standard of performance in heat insulation among various forms of asbestos and a range of compositions. Many of the latter, however, were relatively valueless and should have disappeared from the practice of insulation.

Many so-called insulating materials are of unspecified composition, and, while specimens may be subjected to test for heat transmission, the composition of the bulk as applied in practice is liable to variations in the course of making up and applying. Such a condition is difficult and even impossible to check.

There has been no instrument available to test the amount of heat conducted through insulation *in situ,* and though efficiencies or rates of heat loss have been, and are, specified, they could not be readily checked on the job.

Despite the amount of attention which has been given to developing good insulating materials, there are still those who are prepared to pay for unspecified "compositions" or "common lagging" of which the performance is unknown or is, at least, conjectural, their one claim being "cheapness". The fallacy underlying their use is that the labor in their application is substantially the same as that of a first-class and reliable material, and the total cost for equal insulation, if or when that may be possible, would even be greater than a first-class material.

It is quite possible by the application of inferior insulating material to increase, rather than reduce, the heat losses. This, of course, only occurs in the case of small pipes covered with very poor material. The heat losses reach a maximum when the outside diameter (d in feet) of the insulation is equal to twice the coefficient of heat transfer by radiation and convection of the insulated pipe.

Fig. 1 shows the calculated heat losses as ordinates in a pipe ½ in. O. D. against

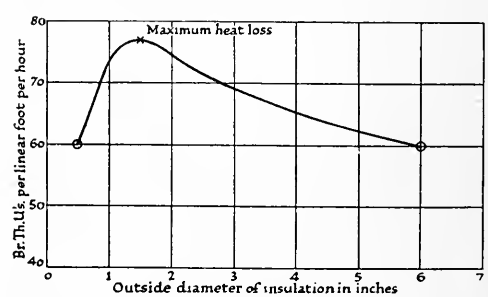


Fig. 1.—Heat loss B.th.u. per linear foot per hour from a pipe at 248° F to air at 60° F (outside dia. = ½ in.) (K for insulation = 0·15)

the outside diameter of the insulated pipe as abscissae. It will be seen that the heat losses on the insulated pipe actually rise above the value for the bare pipe, and do not fall to that of the bare pipe until the outside diameter is approximately 6 in. (equal to 2.8 in. thickness of covering).

The material considered is dense asbestos.

Upon the general adoption of superheated steam the practice of insulation entered on a new phase, as the materials which had served on boilers and pipes with saturated steam at temperatures up to about 350 deg. F. or even 400 deg. F. were unsuitable.

With superheat came not only the temperature but the attendant expansion problems, and whereas the expansion of a 10-ft. length of steel is about $\frac{5}{16}$ in., from 60 deg. F. to 380 deg. F., the corresponding figure when carried to 800 deg. F. is about $\frac{3}{4}$ in., and insulations which could stand up at the lower temperatures were found to come loose, due to decomposition or disintegration combined with lack of resilience and perhaps, vibration.

Materials used as insulation have negligible expansion under heat, and, if applied as plastic, can only follow the extension of the heated metal by loosening the hold on the metal or separating into small units divided by tiny fissures.

Those applied without adhesion must allow the pipe to slide within them, or, if resilient, like glass silk, follow the surface on which they are mounted. During recent years new forms of insulation have been developed to meet the conditions of superheated steam at temperatures above that at which magnesium carbonate decomposes. This results in greater diversity than ever in insulating practice, so that the engineer is confronted with a rather complex problem when specifying, and many specifications which have been standardized in years past have needed revision.

Tire Traction Bugaboo

By Albert H. Oldham
(From India Rubber World, May, 1933)

As is well known, the tire industry has experienced a gradual change from high pressure small cross-sectional tires to lower pressure and larger cross-sectional tires. The larger, softer tires primarily afford a smoother and better cushioned ride. However, in addition, there appears to be a public acceptance of the thought that the larger tires possess better traction and non-skid qualities. This general belief is shared apparently by many experienced tire men. The purpose of this article is to point out and prove in general the fallacy of the "big tire—better traction" theory when the tires are subjected to usual operating conditions.

Perhaps some of the readers will recall performing a simple experiment back in the physics laboratory in high school or college which consisted in taking an ordinary flat building brick and laying it on its face on a table and pulling the brick along with a spring balance while reading the pull or force required both for starting and continuous movement. The experiment was repeated with the brick standing on edge. Much to your surprise the force or pull required in each case was the same,

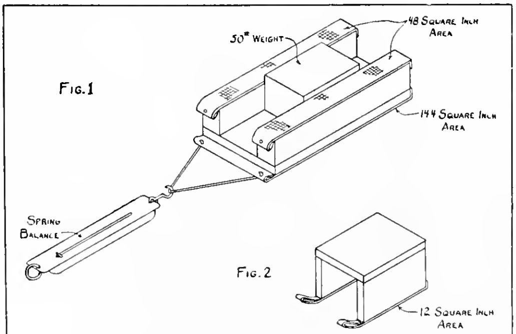
thus indicating that friction between two bodies in contact is constant as long as weight is constant, regardless of surface area in contact.

As a matter of fact any good rudimentary physics text-book dealing with friction, such as Smith or Duff, will contain a statement of the well recognized law which is sometimes expressed as follows: The total frictional resistance is independent of the area of contact.

To settle the question from a practical standpoint, however, a series of tests were run with apparatus such as shown in Fig. 1.

In Fig. 1 the apparatus was designed so that the weight of 50 pounds could be distributed over 144 sq. in. of mat surface by using the mat faced wooden block with one side down or so that the same weight could be applied to only 48 sq. in. of similar mat surface by turning the block over.

From the foregoing admittedly crude experiments it will be evident that ordinarily, as long as the weight remains constant, the force required to start (static friction) one body sliding over another and the force required to keep the said body moving (kinetic friction) is independent of area of surface contact. In the tests very little difference was found in



the static and kinetic readings. However, the static was slightly greater in certain instances, and the static readings were accordingly recorded below.

It will therefore be recognized that in the question of the relative traction qualities of high and low pressure tires, as long as the weight carried by each wheel or tire is the same, the old high pressure, small cross-sectional tire and the present-day low pressure balloons theoretically and actually possess substantially the same traction and non-skid qualities on hard supporting surfaces.

It is to be understood distinctly that while different mat areas were used, the mat surface was all the same in that the different sized mats were all cut from one large piece having a similarly corrugated surface. It is thus evident that the present article is not concerned with the effect of different tread designs upon the question of traction, which is an exhaustive and treacherous subject in itself.

Thermostatic Heat Control for Power-Shovel Motors

By J. E. Borland, Mining Engineer
Westinghouse Electric & Manufacturing Co.
Pittsburgh, Pa.

(From Engineering News-Record, July 13, 1933)

ELECTRIC-SHOVEL motors have three possible operating conditions that make the problem of overloading protection extremely difficult—unusually hard digging with high motor currents, clogged ventilation or failure of blower motor if force-ventilated, and the possibility of a high ambient temperature. The primary consideration is to be certain that the total

temperature inside the motor is below the point at which the insulation will be damaged. Motors are rated on the basis of a certain temperature rise, and whether they will be damaged by excessive overload depends to a considerable extent on the ambient temperature, type of insulation, method of ventilation and other indefinite conditions.

Overload protective devices commonly used for industrial work are not suitable. Because of this, variable-voltage power-shovels are made more or less self-protecting by applying generators with poor voltage regulation. That is, as the current increases, the voltage decreases. Under ordinary conditions this inherent limiting of the maximum current is sufficient, but a recent development making possible the mounting of a small thermostat directly on the motor gives much more complete overload protection that has ever before been possible.

The thermostat may be connected in the control circuit to stop the motor automatically when it approaches a dangerous temperature, or, as might be preferred by the average operator, the thermostat may work a signal, warning the operator of an excessive temperature.

Maintenance and shutdown cost for repairs can probably be greatly reduced by this system of temperature indication or control.

ENGINEERING PROGRESS

NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

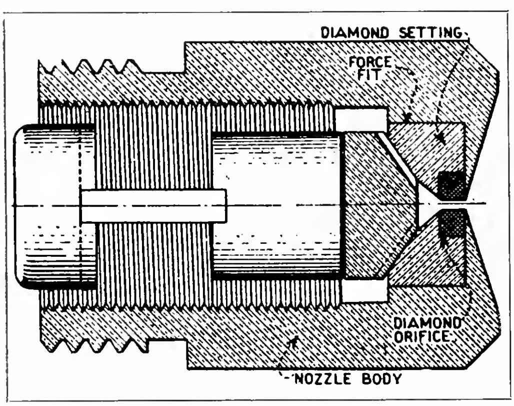
Diamonds in Oil Burners

MOST of the oil burners used in homes today are of the so-called pressure type, in the operation of which the oil is shot from a tiny nozzle into the furnace in a finely atomized spray. The nozzle, ordinarily of some metal or alloy, is generally subjected to erosion and corrosion by the sulfur and acid content of the fuel oils. The diameter of the nozzle orifice consequently undergoes a change and the efficiency of the furnace is lowered.

To eliminate this trouble a diamond orifice has been developed. The type of diamond used for this orifice is the clear light gray or clear light brown industrial diamond. Except for color the industrial diamond has the same physical characteristics as the precious stone. It is therefore perfectly suited to the work it does. The main features are: extreme hardness; complete resistance to acids; resistance to intense heat without change, flaking, cracking, or becoming porous; resistance to abrupt violent changes of temperature; ability to take an exact, precise contour and diameter and hold them without wear from erosion or corrosion.

The diamond orifice is made by drilling a perfectly round hole, very small in diameter, generally from 13 to 25 thousandths of an inch, in a small diamond. The drilled diamond is then mounted in a special metal which is impervious to the acids in petroleum and relatively resistant to erosion. The nozzle mounting is equipped with tangential slots to aid the atomization.

Severe tests of the diamond-orifice with carborundum grains mixed in the oil used indicate that the life of the nozzle may be figured at something like five years.



Sketch Showing Use of Diamond.

Transmitting Oil Pressure Gage

IN AIRCRAFT engines and in other devices exposed to the cold, oil pressure gages become altogether unreliable when the oil in the gage line "freezes". This new instrument employs a non-freezing liquid in the capillary between the Bourdon spring and the ingenious diaphragm, which is bolted directly to the oil pump case by means of a special hollow stud. The principle of the device is appar-

ent from the diagram. Not only does the gage indicate at all times the true pressure in the oil pump, but if the capillary should break there would be no loss of oil as the flexible container would simply collapse on itself and seal the oil.

Valve for Bleeding Gas Under Vacuum

UTILIZING the properties of metallic mercury and of fritted glass filters, a new valve recently developed for introducing gases at low pressures into highly evacuated systems avoids the uncertainty of plug cocks and similar devices. Fritted glass filters with very fine pores will not permit the passage of liquid mercury but offers low resistance to gas flow. When two filter faces are brought together, the mercury between them is squeezed away, leaving a free passage for gas from one to the other. This principle is employed in the accurately regulated introduction of low pressure gases into high vacua, as is required in the radio and incandescent lamp industries.

The apparatus consists of two Jena glass filters facing each other in a bath of mercury. The upper one is sealed into a glass tube connected through a flexible glass spiral to the evacuated system and projects into the mercury. The lower one, of larger area, forms the bottom of the mercury bath and its under side is connected to the flask containing the rare gas. A piece of metal enclosed in the connecting tube allows the tip of the gas flask to be broken off by shaking, after its contents have been protected by sealing the flask to the assembly. The depth of the mercury required is determined by the pressure of the gas in the flask, if that be greater than atmospheric. In order to operate this device it is only necessary to press the upper filter disk on to the lower one and hold it there until the proper amount of gas, as indicated by the pressure, has passed. The apparatus may be used in other places than the high vacuum field. By increasing the head of the mercury column over the filters to the required point, pressures above that of atmospheric can be safely handled through the same valving arrangement without leakage or contamination.

Cutting Steel with Water

IT HAS recently been announced that the cutting of hard alloy steels by means of an insignificant small jet of water has been accomplished. This discovery is of great value in the design field of engineering, and consequently the method used in cutting the steels with the water is of great importance.

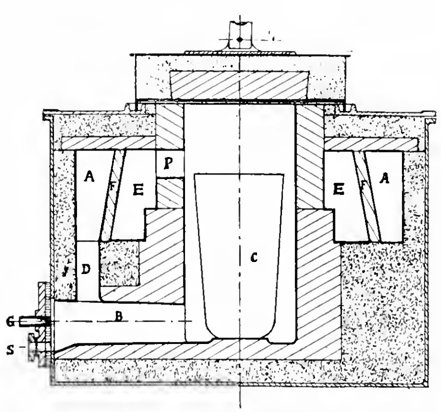
The immediate object of the research was to determine the rate at which metals wear away when rotating at a high speed in a moisture-laden atmosphere. As it is evident that this condition is the exact reproduction of what happens to airplane propellers spinning through mist, fog, and rain, or to turbine blades rotating through their atmosphere of steam, the practical benefits of this research development to the industries involved are very great.

The actual cutting operation was performed on test plugs mounted to the rim of a disc wheel rotated by a geared electric motor at a speed of 13½ miles a minute.

Two specimens were tested at a time. Each time the disc wheel revolved the plugs cut through a small stream of water about the thickness of a lead pencil. The impact of the steel on the water stream filled the enclosing chamber with a fine mist and duplicated all the wear on a propeller due to months of flying through rain and fog, or on steam turbine blades during years of service. The erosion is so rapid that quarter inch specimens of stainless steel are cut halfway through in three minutes.

Gas Crucible Furnace

A NEW type of gas fired crucible furnace has recently been made available to manufacturers. The furnace consists of a heavy cast iron casing lined with a suitable insulation material, shown in dotted lines in the figure. There is an inner refractory lining. The air is preheated by external and internal recuperators. The crucible (C) is supported on a small raised stand. If it cracks and allows the metal to run into the furnace, a fusible seal (S) is melted and the metal drains off without any interference with the supply of gas. Gas issues through the nozzle (G) and induces the air with it in the induction tube (B). The gas and air enter the main chamber of the furnace tangentially and burn while the mixture swirls around the crucible before passing out through the exhaust port (P) into the exhaust flue (E). The hot exhaust gases then travel round the exhaust flue and heat the air in the flue (A) through the refractory wall (F). They then pass into the external metal recuperator and give up still more of their heat to the incoming air before passing up the flue. This air is thus heated before it enters the flue (A) in which it is heated still further before it passes through the downtake (D) into the induction tube. Since the gas and air are not mixed before they are ignited, a much softer flame is obtained that does not cut the crucible or the lining, as is often the case with gas-fired or oil-fired crucible furnaces.



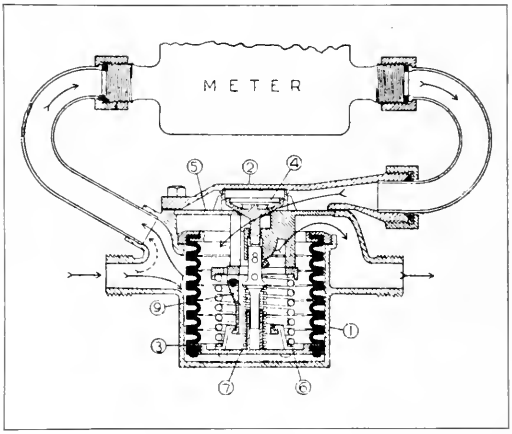
Gas Fired Crucible Furnace.

Gulper for Liquid Meters

SMALL flows are not registered by ordinary water meters. In this way consumers do not pay for billions of gallons wasted through fixture leaks or utilized in gas refrigerators and for other purposes where water is "dribbled". The same is true in the metering of other liquids where the same problems of under-registration and non-registration occur. The practical solution of this problem has been found in a new device which is called a "gulper". The principle of this instrument is the accumulation of the liquid to be metered

in a reservoir and then allowing the liquid to pass through the regulation meter at a rate of flow sufficiently large so that the meter will accurately register the flow. For proper operation of the "gulper" the meter must be set at an angle of 60° with the gulper spuds and service line, and must be located directly above the "gulper".

On small flows, water entering the inlet of the instrument cannot pass through the meter because the valve is closed. The small flow to the discharge of the "gulper" comes from the inside of the bellows, which are compressed by the inlet pressure on the outside of them. The contraction of the bellows compresses the main spring and the valve spring. When the bellows is compressed to a certain point, the tripping mechanism, operating on the toggle principle, permits the valve spring and push rod to snap open quickly the gulper valve, permitting water to pass through the meter. The bellows and main spring, being under compression, expand and force a volume of water equal to the bellows displacement up through the meter, through the valve, and into the inside of the bellows. During this time the gulper water passes through the meter at a rate of almost 2 gals. per min. The expansion of the bellows pulls the valve down to within about one-sixteenth of an inch of its seat from where it drops the remaining distance. A circular slot through the valve just above the point of seating permits the pressure at the point of greatest velocity to be exerted inside the dashpot above the valve. On flows above one gal. per min. the velocity past the valve is sufficient to cause this pressure difference to support the valve, holding it in the open position and permitting a steady flow through the meter.



Sketch of "Gulper".

Definition

Radio—just a home for the old jokes.

Real Pals

Well, there's one thing we have to say for our creditors—they've stuck with us through all of the depression.

We understand Cuba salutes her President in the same manner we do—21 guns. But their aim is not so good.

The necktie manufacturers had a squabble over their NRA code—it ended in a tie.

Suggested research work for unemployed graduates:

1. Black bathtubs to eliminate the Saturday-night ring. (Big field.)
2. Cross a homing pigeon with a collar button. (Practically no competition.)

Davidson: Was your bachelor party a success?

Colburn: Rather, we had to postpone the wedding three days

Milli-amps and micro-farad
The happy thermo-couple.

"Why is there so much electricity in my hair?"

"Because it's connected to a dry cell."

Social Science Prof: "Mullane, what is the International Law on straights?"

Mullane: "A straight flush beats a full-house."

Missing from the Faculty

We'd like to meet the absent-minded professor who lectures to his steak and cuts his classes.

You might say that hockey sticks cover a multitude of shins.

Then there was the street cleaner's daughter who swept me off my feet.

The loon is a funny bird but it takes the stork to kid us along.

Oil burning locomotives cannot help but be hot since they are never coaled.

G-E *Campus News*

TALK FOR TRAINS

ON a track near Schenectady, a few weeks ago, several visiting trade-journalists sat in a test car. From a loudspeaker in this car came a running stream of information. The voice was that of a G-E engineer in a "station" a half-mile down the track. Sample remarks: "Believing that we could help railroads to speed the movement of freight trains, G.E. has now produced this device — a new system of communication. It's not radio, but, in principle, direct telephony. It's a distant cousin of the carrier-current communication that power companies use. They talk over the power lines; we use the rails, plus any wire line along the track. Now, the man in the caboose can talk with the man in the cab. It also works between trains up to 5 miles apart, and between trains and stations. Loud-speaker reception overcomes the train noises. Can you hear me all right?" They could.

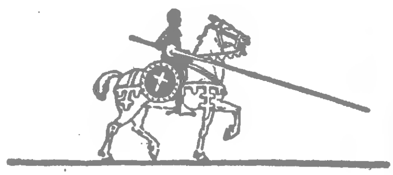
Dr. Ernst Alexanderson, a G-E Consulting Engineer, is responsible for this development. He is a 1900 graduate of the Kungliga Tekniska Högskolan, Stockholm, Sweden. Incidentally, a partial indication of his versatility in engineering design will be found in the U.S. Patent Office, through which he has been granted more than 200 patents.

SMOKE IN THE EYE

AN eye in the stack is worth two on the ground. So thought G-E engineers as they finished mulling over the smoke-nuisance problem of power and heating plants.

A light source and a photoelectric-relay unit were installed in stacks in Chicago and New Jersey. They are so arranged that when the stack is clear, light falls on the phototube; a meter or recording instrument registers zero smoke density. As the density increases, the phototube receives less light and indicates an increase in density. An adjustable electric contact is provided to operate an alarm. (A running record of the amount of smoke passed up the stack can be obtained by adding a recorder.) Thus, the "electric-eye," which is not affected by cinders and is never closed in sleep, has found another way to be of service.

Two G-E engineers, W. R. King and Pieter Juchter, developed this new smoke-density indicator. King is a '28 graduate of the U. of Kentucky, and Juchter a '24 graduate of the Eidgenössische Technische Hochschule, Zürich, Switzerland.



A RÖNTGEN WARRIOR

FOR the doctors who are waging continuous warfare against the dread, lurking specter of cancer, G-E research men believe they have provided another shining sword. Again they have produced the most powerful x-ray tube ever built — this time, for continuous operation in practical cancer therapy at the Mercy Hospital, Chicago. Dr. E. E. Charlton, Grinnell College, '13, is the man who directed the production of this tube.

The giant tube (brother under the glass to those in your radio) measures more than 14 feet in length, is rated 800,000 volts, will treat patients in a fraction of the time required by the last "most powerful" one, has x-ray radiation equivalent to $75,000,000 worth of radium (if there is that much!) and needs 20 gallons of Lake Michigan's coldest water every minute to keep cool.

It's a pleasure to make good motors and good lamps. It's a greater pleasure to help alleviate human ills—all in the line of duty! More tubes are on the way.

96-4FBI

GENERAL ELECTRIC

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Man's Achievement — Nature's Grandeur

Courtesy General Electric Co.

THE
ARMOUR ENGINEER

JANUARY, 1934

Atmospheric Electricity

By CLARENCE HUETTEN

AMONG the more generally recognized effects of atmospheric electricity are lightning of innumerable types, polar auroras, and perhaps slightly less known St. Elmo's light. Other effects such as atmospheric potential, vertical convection currents, and earth currents are recognized even to a lesser degree by the popular mind.

It has been known ever since Le Monnier (1752) that there exists everywhere and at all times, even on a fine day an electrical potential difference between the earth and the air. It averages about 100 to 300 volts the first meter above the ground and is very nearly proportional to the height. Before considering the effects it might be well to examine for possible origins.

In 1785 Coulomb charged a metal body and found that it lost its charge in air. This, in itself, appears insignificant, but it led to a multitude of experiments. It had always been conceded that a charge on a given body was retained better in dry air than in moist air. Experiment proved

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Clarence Huetten is a senior student in the Department of Electrical Engineering. He is a member of Tau Beta Pi, honorary engineering fraternity.

the converse to be true. The ionization theory was set up as an explanation of the loss of charge. Dry air at ordinary pressures, although one of the best electrical insulators known, is not perfect. The various gases are composed of molecules, each carrying an equal positive and negative charge under normal conditions. Upon having an excess of one, it becomes an ion. Upon this basis the conduction of air is easily explained. It also accounts for the ability of the air to hold a charge. As to the charging agency there are several theories.

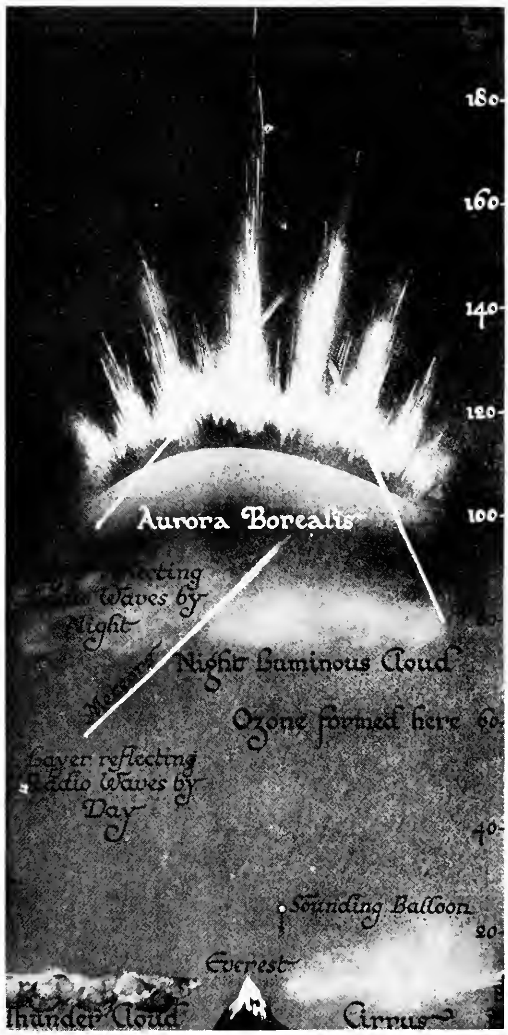
Among the oldest theories are those of Erman (1803) and Peltier (1836), which supposes that the earth has an inherent negative charge. Exner, a modern supporter, strives to explain potential variations to the action of aqueous vapor which upon evaporating carries negative charges with it. This is based on experiments of Mascart (1878), who observed that evaporation took place more rapidly from an electrified liquid than from a neutral one. Negative charges would reside at the outer surfaces due to mutual repulsion and due to this repulsion, evaporation should increase. With the limited facts obtainable this theory appears very improbable. Suppose this terrestrial charge to exist. The charge would reach a position of equilibrium at the outermost strata of atmosphere and in such a case its resultant effect on internal charged bodies is zero as may easily be shown. Now, as for a potential distributing agency, any considered would work with or without this initial charge. From this point of view the inherent charge would be extraneous to the necessary theory to cover the phenomena. It is true, however, that rain is usually negatively electrified. Several experiments have been made with the view of supporting the theory of evaporation, but gave it no conclusive support.

Edlund's theory of unipolar induction considers the earth as a rotating conducting sheath within which a magnet is situated. Then by simple induction this would cause positive electricity to accumulate in the upper atmosphere. While the upper atmosphere seems to have a charge such as has been suggested for the Heaviside layer there do not seem to be any supporting evidence. If this were true that there was such relative motion between the earth and a magnetic field, a conductor held vertical should have an emf. induced in it.

A similar and infinitely more probable theory explains the electrified nature of the upper atmosphere, daily thunderstorms in equatorial regions as well as the polar auroras. Upper regions of the atmosphere have a smaller angular velocity than the earth. This may be due to convection. Let a given mass of air near the earth's surface have a rotational velocity equal to that of the earth and the corresponding tangential velocity $\omega_1 h_1$ or V_1. As the air referred to rises h_1 increases to h_2. V_1 will tend to remain the same due to the conservation of energy $\frac{1}{2}MV_1^2 = \frac{1}{2}MV_2^2$ and $V_1 = V_2$ or $\omega_1 h_1 = \omega_2 h_2$. Since h_2 is greater than h_1, ω_2 must be less than ω_1 and hence a lag in rotation. Air, being a conductor, cuts the earth's magnetic field between the poles and the equator causing a maximum difference in

potential at the equator and the poles. The direction of the emf. would be from the equator to the poles. The daily thunderstorms in equatorial regions and the polar auroras may be but the completion of the electrical circuits. The aurora, while greatly varied, is certainly of an electrical nature. It may be this accumulation of charge which discharges in the rarefied air. The current flow seems to be from the upper regions to the surface. It occurs at various heights from as low as a mile and a quarter to as high as ninety miles. The upper limits are often bounded by a yellow glow. It is very similar to discharge in Geissler tubes where the gases are made luminous by discharge. In addition, the so-called Heaviside layer may be due to a charged upper atmosphere resulting from causes mentioned above. Local thunder storms and their lightning may merely be due to the cumulative effect of the clouds. The formation of small drops of water is one of the best methods of getting the potential of a gas at a point. Gases will conduct much easier under lower pressures which probably explains upper atmosphere conductions.

Another interesting theory ascribes atmospheric electricity to friction of ice on water particles, where ice becomes positively and water negatively electrified. Sohncke first suggested this theory. The actual electrification was first shown by Faraday and later checked by Sohncke. All the air contains considerable moisture and at some great height the temperature and pressure conditions are such as to cause the moisture to be tiny ice spicules. The friction and contact with strata containing unfrozen water causes the layer of lower temperature to become positively electrified and the other to pass to the earth by means of precipitation. This would also coincide with the fact that rain is usually negatively electrified. The theory ascribes the charging to friction but by present theories, if it is true at all, it is due to intimate contact and independent of friction. It has been shown that the various



Courtesy "Popular Mechanics."

Sketch Showing Upper Air Conditions.

charging devices are only means of getting close contact and separating the charged bodies. For instance, experiments with paraffin and water have been performed with absolutely no surface friction. The work is done in the separation of the charges.

The photoelectric theory first proposed by Arrhenius and sometimes referred to as the Hallwachs effect was modified and fully developed by Elster and Geitel. It considers the negative electricity of the earth's surface as dissipated into the atmosphere by action of ultraviolet light from the sun. It was Elster and Geitel who first observed that a negatively charged body dissipates its charge more quickly and also that air was a better conductor in sunlight. Negative charges seem to be more mobile.

Among the various theories the photoelectric theory seems to be more generally accepted at present. However, in the various articles attributing atmospheric electricity to ultra-violet light, they are vague in the actual mechanics of what takes place. The combination of the ionization by ultra-violet light and the distribution by what is called the ion theory of atmospheric electricity gives a quite complete explanation of the phenomena.

Of the radiation from the sun which reaches the earth's outer atmosphere, it is estimated that about 1/3 is lost by scattering and reflection into space, 1/3 is absorbed in the atmosphere, mostly in the highly rarefied region of the outer atmosphere, and 1/3 reaches the earth proper, most, if not all of which is later reradiated. The absorption of radiation is one of the causes of ionization of the air.

J. J. Thompson, who first suggested the ion theory of atmospheric electricity (J. J. Thompson, Phil. Magazine XLVI, p. 533, 1898), says, "If negative ions, say, were to differ in their power of condensing water around them from the positive, then we might get a cloud formed around one set and not around the other. The ions in the cloud would fall under gravity, and thus we might have separation of plus and minus ions, and the production of an electric field, the work required for the production of the field being done by gravity." C. T. R. Wilson actually found that it required greater expansion to produce a cloud on positive ions than on negative and he says he considers that if ions ever act as condensation nucleii in the atmosphere, it must be mainly or solely the negative ones and they are the ones to be carried to earth by precipitation. (C. T. R. Wilson, Phil. Trans. Nature LXII, p. 143, 1900). Hence we have a potential distribution. It is believed that solar radiation absorbed in the lower atmosphere is mostly expended in charging particles of moisture. The conductivity of air depends upon the mobility of the ions; so ions attached to droplets of water become slow moving. Here we see an explanation for the previously mentioned poorer conductivity of moist air.

We have seen that an electric field is in effect between the air and the earth regardless of how it originated. We have also seen that the air is a conductor. The earth being normally negatively charged, there would be nothing unusual in expecting a current to flow from the air into the earth and this is exactly what happens.

This vertical convection current amounts to an average of 2.10^{-16} amperes per square centimeter. Integrated over the whole surface of the earth this amounts to more than 1,000 amperes. This considers only the current at normal positions between the poles and the equators. It would probably amount to much more taking the increased discharges at the equator and the poles. To use a hackneyed expression, "What goes up must come down," we see that quantities of electricity go up due to one of the causes mentioned, or possibly several of them, and come down by pure conduction of the air or in rain or snow.

St. Elmo's light, or fire, as it is sometimes called, has been observed by relatively few people. Because of its occurrence at sea it has come to be regarded as either existing there alone or as part of a yarn of the sea. In contradiction to this it is found that it is far more common on the peaks of high mountains. From Colorado Springs it was seen fourteen miles distant, on the top of Pike's Peak, and was thought to be hikers stranded. Aviators investigated and found no sign of life. St. Elmo's fire is but an electrical discharge similar to lightning but of a less disruptive nature. It is effective on pointed conductors in particular as may be expected. Franklin showed the discharging power of points due to their resulting large charge density. However, contrary to lightning, the author believes that this discharge is not the direct discharge of charged clouds, but the result of induction. A passing cloud which is electrified, according to this theory, would induce an emf. in the various conductors. Discharge, then, takes place from the pointed conductors. By conductors this does not mean metal alone. It has been seen to issue from house tops, the pyramids, and even from parts of the body such as the finger tips, hair, and at times the saliva from the mouth.

There are innumerable records of the light. A phenomenon similar to St. Elmo's fire is "Andes lightning." During warm weather the tops of the Andes in South America are often seen to be aglow and great searchlight-like beams shoot up to heights great enough to be seen from the west coast and even hundreds of miles out at sea. It has been explained as being the reflection of glowing lava from the craters of volcanoes by the natives, but it has been found to be otherwise. At times the Alps give a similar but smaller display.

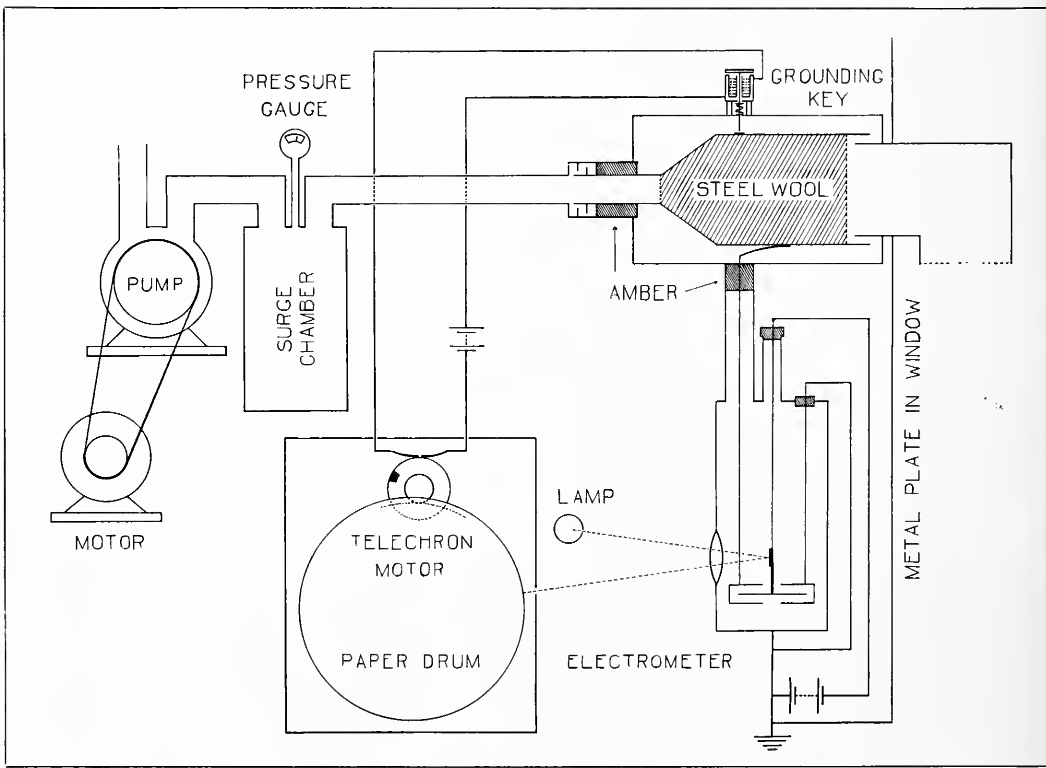
If we were to trace the atom of air in its part in atmospheric electricity according to the previous theories we would find it acting as follows:

The atom may become ionized by "friction"; that is, it may get in intimate contact by force due to wind and, although it would formerly have been said that some electrons were brushed off, we can at least say a transfer of electron or electrons takes place. Also the ultra-violet light may be the ionizing agency. It being a rapidly alternating electromagnetic wave would send the negative charge in our little atom back and forth at a tremendous rate and perhaps knock it out of its orbit. This assumes its natural frequency equal to or less than that of the light. This seems to be a possible explanation of the mechanics of this ionization directly in terms of Faraday's law of generated emf.

The ion and its complement may be separated by induction as suggested or by water condensing around the negative ion and gravity bringing it down to earth. It may then satisfy its attraction for the opposite charge by a transfer through space in the form of a convection current, polar aurora, lightning, or perhaps St. Elmo's fire. The cycle is completed and it is ready for another.

The simplest method of measuring the potential at the place in question is to put a point there and a conductor which leads into an electroscope whose case is grounded. Saussure used an instrument of this type but the point is too imperfect to assume the exact potential at that point.

The effect of a perfect point is had with W. W. Thompson's water dropping apparatus. It provides an easy way of observing atmospheric electricity. He describes it himself as "merely an insulated can of water set on a table or window sill inside which discharges through a fine nozzle two or three feet from the wall. With only ten inches head of water and a discharge so slow as to give no trouble in replenishing the can with water." He states that the atmospheric effect is collected so that any difference of potentials between the insulated conductor and the air at the place where the stream from the nozzle breaks into drops is done away with at the rate of five percent per half second,



Schematic Diagram of Space-Charge Apparatus.

Courtesy of "Terrestrial Magnetism and Atmospheric Electricity."

or even faster. Measurement of the potential may then be made with a quadrant electrometer.

Electrification by friction is easily shown by the use of a Kelvin-Mascartelectrometer charged by a battery whose center is grounded. The needle being connected to a Mascart's insulator, fine sand may be poured from an insulated funnel suspended by a silk thread on to some article such as wood, leaves, etc. The object becomes positively and the sand negatively charged. In nature when it is dusty and there is a strong wind we see this experiment taking place as far as the electrification goes. Modern instruments permit not only potential measurements but space charge measurements as well.

Experiments have been made by M. Lemstrom on a large scale on the production of the aurora. A network of copper wire was constructed covering about 900 square meters on an elevated area in the polar regions with a number of points directed to the sky. He succeeded by this in obtaining the peculiar ray of the aurora.

Upon first learning of atmospheric electricity it is only natural to ask if here we have a vast reservoir of energy. When it is considered that 1/3 of the energy of the sun which reaches the earth is used in ionization, we must either have a store of energy or the figures are wrong. At one mile in the air we have a potential ordinarily about 100,000 to 150,000 volts. This in itself indicates no energy but there is an average convection current of about 1,000 amperes which does indicate an expenditure of energy. There is a reverse current or transfer of ions in the form of lightning, etc. The energy of a single stroke of lightning in a brief surge of 50 microseconds amounts to 200 kilowatt hours of energy. Can we utilize this electric current or is it merely heating up the earth as a step toward the "heat death of the universe", which the second law of thermodynamics teaches us is unavoidable?

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Air Conditioning for Comfort

By ROBERT G. GUTHRIE

THE expression "air conditioning" may be a very general phrase and again it may be used as a very specific phrase. Its meaning is frequently ambiguous and it is rather difficult to give any general definition which will fit the term in all of its aspects.

For example, air conditioning in one form or another has been used technically for many years and never recognized as such. The use of calcium chloride in a desiccator in chemical laboratories for removing moisture from the air contained within the desiccator has been common practice for a long time. The use of heating or cooling mediums in a room, or, if hairs are to be split, the use of any circulating medium such as a fan in a room or other compartment or container, may also be considered as air conditioning. There are any number of technical applications that might be properly classified under the general term of air conditioning, such as refrigerated rooms for the temporary preservation of perishable foodstuffs, and especially constructed drying rooms for the dehumidification, cooling, or both, of air in a room to promote the comfort of the occupants during otherwise uncomfortable weather. It is usually thought of in connection with the summer season, but equally important is winter air conditioning and although heating air in a room during the cold weather is in itself air conditioning, that phase could be more properly referred to as temperature control.

This article, therefore, will deal with summer and winter temperature controlled air conditioning for the comfort of the human body and would properly apply to rooms in which we live, work, sleep and play. There are a great many ramifications and conflicts of ideas among the lay public as well as among professional men regarding the proper method or combination of methods required to condition a room, and an endless number of machines and appliances have been built incorporating ideas to produce conditions designed to promote comfort.

Robert G. Guthrie is Chief Metallurgist for the People's Gas Light and Coke Company. He is a former Armour student and has been doing a great deal of work in the air conditioning field for his company.

The first consideration in this regard is that the human body varies in every individual and hence also each person's nervous system. Some people are extremely sensitive to temperature, humidity, drafts and so forth, whereas others are not affected unless the temperature range falls outside a fairly well-established limit. In other words, there is a comfort limit for the normal person in regard to temperature, relative humidity, and so forth, so that if a set of average conditions can be maintained in a room almost everyone who comes into that room will be comfortable.

The first thing to consider is that no air we normally encounter in our homes is entirely dry; likewise, under ordinary circumstances, no air is absolutely wet. All air with which we normally come in contact contains a considerable amount of moisture which is a variable, depending upon many things—principally temperature. Almost everybody knows the old saying, "It isn't the heat, it's the humidity," but comparatively few realize the mechanism by which this affects one's self.

When moisture is condensed from air by any means, there is a heat increase in or on the condensing medium and the surrounding air equivalent to 970 British thermal units per pound of water condensed. (The British thermal unit is the quantity of heat required to raise one pound of water one degree Fahrenheit.) When water is evaporated, the reaction has a cooling effect at exactly the same rate of 970 British thermal units per pound of water evaporated.

The next consideration is how this relates to the human body. Under normal conditions, the human body is a very excellent refrigerating machine in that, when it is uncomfortably warm, it begins to perspire and this perspiration is exuded from the skin for the purpose of evaporating and thereby lowering the skin temperature. The extreme in this is often experienced when one leaves the water while a strong wind is blowing, which increases the evaporative rate and thereby very materially lowers the temperature of the surface of the skin and causes an uncomfortably cold or chilly feeling. On the other hand, when the air is already saturated with water, it obviously does not have the property of absorbing water from a moist surface and although the body continues to exude perspiration in an effort to lower the surface temperature of its skin, the air, having a high relative humidity, cannot take up the water and consequently the evaporative rate from the surface of the skin is very slow, thus keeping the skin temperature relatively high so that the individual is very uncomfortable and is bathed in perspiration.

A good example of the evaporative cooling effect is found when a person perspiring profusely stands in front of an electric fan. The fan has no property of cooling air and thermometers placed in front and back of the fan will register essentially the same. Nevertheless a sensation of coolness is felt because the rapid evaporation of moisture from the surface of the skin gives this sensation and rapid evaporation takes place because the air passes over the skin at a much greater rate than as if no fans were employed and at any humidity under complete saturation with water va-

por, the air will of course pick up moisture faster than if the air were still.

With the above points in mind, let us look for a moment at the two general systems of summer air conditioning now in use. The one most commonly encountered is simply that of blowing air by means of fans over ice, coils of a refrigerator, or any other medium, making the temperature lower than that of the surrounding atmosphere. This, of course, results in actually lowering the temperature of the air passed and this system is not properly referred to as air conditioning but rather as air cooling.

The second system is one in which a part of the moisture is removed from the atmosphere by adsorption by the use of some chemical. In this case, the air is said to be truly conditioned and requires comparatively little cooling as the human body will automatically take care of its own comfort when it is supplied sufficiently dry air to increase the evaporative effect from the skin.

In an article of this length, it is impossible to cover the relative advantages and disadvantages of these two systems, but it seems logical to assume that the second system will eventually supersede the first for the very basical reason that if a person enters a room using the first system—that of merely cooling—and is in a perspiring condition, very little drying out will be accomplished and the extremely uncomfortable condition of having on cold, wet garments will be experienced; whereas, if this person enters a room in which the relative humidity is materially lowered by an air conditioning system, the cooling effect is experienced by the rapid evaporation of perspiration and consequently the person not only dries off, so to speak, but is very comfortable during this drying off as well as afterwards so long as he remains in this atmosphere. In addition, there is no shock to the system.

Sufferers from the so-called "allergic" diseases, such as hay-fever and asthma, are materially benefited by the second system because of the lower relative humidity, but generally are not benefited by the first system.

The equipment necessary to satisfy the first system usually consists of a blower or some sort of fan, and in the electric unit there is a small refrigerator incorporated in which the air is blown over the coils and allowed to enter the room in which the temperature is to be lowered.

In the second system, the air is taken, also by means of fans or blowers, over and through beds of some chemical having the property of adsorption (the property of condensing a condensible vapor from the gaseous to the liquid phase and holding it upon its surface or absorbing it within its interior). The air then may or may not be cooled, but in any event it enters the room with a very much lower humidity and consequently has the beneficial and comforting drying and cooling effect mentioned before.

A classic example of this was shown last year during the extremely hot weather. Several people were taken into a properly air conditioned room, allowed to remain a few minutes and were then asked to guess the difference in temperature between inside and outside. Prior to their

entry they had been shown a thermometer outdoors which registered some 90° F. In each instance, the person guessed that the room was approximately 15-20° colder and, when shown the inside thermometer, were very much surprised to learn that there was less than 5° difference.

In Chicago the relative humidity of outdoor air in the summer ranges anywhere from 40% to 90% whereas in the winter it is from 1-2% up to 40%. As a general thing, comfort indoors or out is realized in ordinary clothing at about 70° F. dry bulb and 40-50% relative humidity. During the winter a person in a house heated to 65-70° F. is usually very uncomfortable as he is too chilly; whereas this same person in spring or summer will be very comfortable outdoors at 65-70° F., and the difference is only a slight percentage of relative humidity. Therefore, the question of air conditioning for human comfort resolves itself into reversing the relative humidity of summer and winter.

For winter air conditioning, it is only necessary to raise the moisture content of the air in a room to 40-50% relative humidity to have comfort at 70° F., which is approximately 10° lower than the average room temperature in most rooms. This results in great fuel economy, much longer life of furniture—particularly pianos and other wooden musical instruments—and a much healthier condition for nose, throat and skin.

Of the chemicals used in the adsorptive or dehumidification system of air conditioning, the outstanding are calcium chloride, activated alumina, silica gel, and the newly discovered lamisilite. The difficulty with some of these is that they are sensitive to handling or to moisture or are too expensive or impractical because of dusting and corrosiveness.

Generally speaking, a new industry of tremendous importance to everybody and particularly to the engineer lies potentially in the air conditioning field for human comfort and health. It has never been possible to get truly fresh air excepting in the high mountain altitudes or very deep in the rural districts and then only with ideal climates. It is possible today at considerable expense and with quite a maze of complicated mechanical apparatus to produce cleaner, healthier and more comfortable conditions in a room in the dirtiest of cities than can be obtained anywhere outdoors within the reach of our travel.

The big problem, therefore, for the engineer is to make this conditioning a practical reality for the largest number of people by lowering, not only the first cost, but the operating cost of such apparatus. This will necessitate ingenuity of design, mass production of the apparatus, and a suitable and low-priced chemical for the adsorption. So it now remains for the engineers to develop suitable apparatus to use such a product.

The problem has advanced towards a successful solution principally because it is well known what factors have to be satisfied to realize nearly ideal conditions. At least one satisfactory chemical exists to accomplish this purpose and all that is necessary now is the arrangement of a unit to be ingeniously enough designed and cheaply enough produced to be applicable.

There has probably never been a field

developed which offers any more possibilities to the engineer than the universal application of air conditioning. Practically everything we come in contact with in our daily lives can be materially bettered by air conditioning and most important of all is our own health and comfort. The potential field is so large and complicated that it is almost impossible to grasp a comprehensive idea of its value to mankind.

The development of the air conditioning field, like many of the other major industries, will result in the development of industries accessory to it which do not exist at present. Consequently there is an opportunity for increased employment as different products must and will be developed. The fact that more than one person at a time can enjoy an automobile was one of the greatest factors in the rise of that industry. This same condition is true to an even greater extent in air conditioned homes of the future because people spend a great deal more time in their homes since the advent of radio and other devices.

A great deal has been written about the marvelous possibilities in the development of better standards of living for people, but proper air conditioning for summer as well as winter comfort is a thing which will be as important to future generations as the replacement of the open wood fire with modern steam heat has been in the past.

Equipment of Automotive Engineering Laboratory

Part Two

By PROF. DANIEL ROESCH

Air Flow Nozzles

ONE series of flow nozzles used in the Automotive Laboratories at the present time have been made with a rounded entrance having a quarter-ellipse sectional curve and a throat length approximately equal to the throat diameter, as indicated for the 0.030 sq. ft. size in Fig. 6. The form was suggested by those described in the Bureau of Standards Journal of Research Vol. 2, of March 1929. The outside dimensions have been made to facilitate connection to the carburetor or other devices with 2½ inch pipe thread. Precautions are taken for engine installation, to enlarge the piping at the nozzle outlet as much as may be practical. Pressure drop connections may be as indicated with the inside hole made small and smooth to reduce wall disturbances to a minimum. (Diameters of 0.020 to 0.040 inches are used). The results of engine calibration of this nozzle at laboratory pressure, temperature and humidity is shown in Fig. 7. The discharge coefficient is less than unity because the straight section does not en-

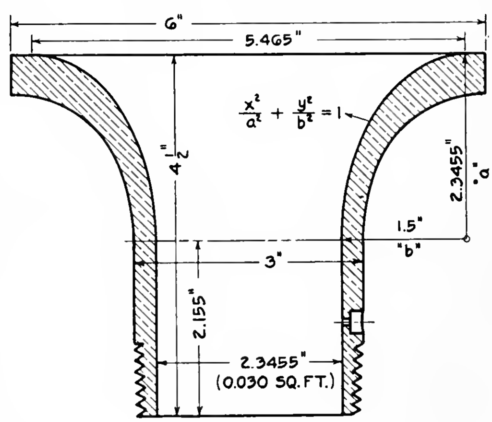


FIG. 6
FLOW NOZZLE

Professor Daniel Roesch graduated from Armour with the degree of B.S. in Mechanical Engineering in 1904. In 1908 he was awarded the degree of Mechanical Engineer at the same institution. He came to the Institute in 1911 as instructor of Experimental Engineering. Since 1928, when he was promoted to Professor of Automotive Engineering, he has remained with the school in that capacity.

tirely fill with air moving at a uniform velocity. The air speed falls off close to the wall and there is a radial component to the entrance flow which may contract the core for a variable distance beyond the junction of the curved entrance and the straight section. The skin friction will of course affect the depth of retarded flow or the core diameter and be dependent upon the internal finish. Air viscosity also is a factor in the change of velocity, characteristic at this point. These effects become relatively less for greater air velocities and tend to give higher coefficients or larger core diameters at higher air velocities. The radial velocity component of the air flowing through the entrance of the nozzles acts toward the axis of the nozzle and tends to decrease the coefficient, and cause higher center velocities. This effect is practically eliminated in the specimen distribution test as shown in Fig. 8, as indicated by the flatness of the center portion of the curve. In any case the combined influences of all the factors affecting the nozzle must be determined by a carefully made traverse or by direct comparison with a primary or secondary standard meter. The nozzle should be calibrated under

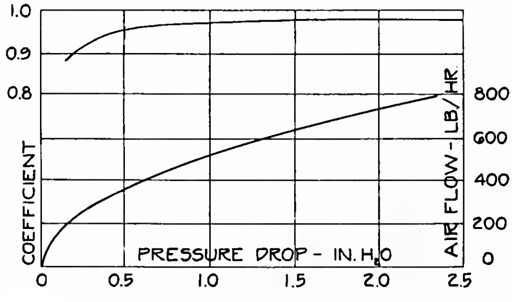


Fig. 7.

Results of Engine Calibration of Nozzle.

the same conditions as will be present during its use. The fluctuations of flow in multiple cylinder engines require individual consideration in the calibration of these nozzles which are designed to be placed close to the engine. This location avoids the ramming effects of an air column which is not regularly on the engine.

Study of the variation in the air velocity of the nozzle shown, has been facilitated by the use of pitot tubes made of hypodermic needles, and a set-up which permits reading the pitot tube position to 0.001 inch directly. The traverse shown in Fig. 8 was made with a pitot tube of 0.008 inch diameter and shows a movement of 2.3625 inches from zero pressure to zero pressure across the nozzle discharge diameter. This traverse was made at 0.010 inches downstream of the nozzle outlet, and therefore practically no flaring out of the air core is shown by the data. The 0.008 inch diameter pitot tube began to record air velocities as soon as its first edge passed into the air core and continued to record air velocities until the last edge of the pitot had moved out of the air core. The air core diameter is therefore the graph length minus two pitot tube diameters or 2.3465 inches. This experimental determination compares to 2.3455 inches by direct micrometer measurements and furnishes one of the inspection checks of the work. The data as taken has permitted almost any magnification of the scales with consistent location of observations which for much of the graph were at 0.0025 inches intervals of the traverse.

Experimental Nozzle Traverse

The discharge coefficient is greatly af-

fected by the average velocity of flow as well as by the wall characteristics. It is, moreover, greatly influenced by the fluctuation in flow. (See H. F. Hagen Paper A. S. M. E. Annual Meeting Dec. 5-32). The practical application of a nozzle to an engine is therefore involved as to the exact determination of the proper discharge coefficient to use in computations. If the velocity head of a single reading is taken as for the conditions noted above, then the apparent coefficient is 96.7% based on the velocity head traverse. If the instantaneous values of velocity head are transferred to a velocity chart as in Fig. 8, then the discharge coefficient is 97.5% based again on a single reading (at the major high velocity section of the core) of the velocity as determined by the velocity head. These figures apply only to the non-pulsating velocity of approximately 60 ft. per second. The latter method of computing discharge coefficients is conventional. These coefficients are further modified by the pulsating flow in the practical application of nozzles to an engine. The practical coefficients shown in Fig. 7 were determined by the direct comparison of this nozzle with a damped-pulsation air-flow test using a calibrated orifice-meter. A consistent engine was, of course, necessary to make the comparison at controlled conditions of operation. It was noted that the coefficients so obtained are substantially lower than the steady flow coefficients, and are limited in their application to engines having the same flow characteristics as the engine used for the calibration of the nozzle. The actual coefficient for use in the engine of the type selected shows 96.0% coefficient for the above nozzle which has a smooth flow coefficient computed as 97.5% by conventional methods using refined equipment. (Velocity pressure drop approximately 0.85 inches H_2O). The engine used was a Chrysler eight cylinder 3x4.25 inch, bore and stroke, in which the intake-manifold-pressure fluctuations were relatively small because of the speed and number of cylinders. Lower speeds and fewer cylinders may be expected to further reduce this coefficient.

Coefficients

The analysis of the exhaust of an internal combustion engine furnishes an index to the mixture ratio. In general, low carbon monoxide means practically complete combustion and a mixture ratio for petroleum hydrocarbon fuels of only slightly under a theoretical ratio of 15 to 1 of air to fuel by weight.

Exhaust Analyses

Commercial operation of automobile engines of the Otto cycle type is around 13 to 1 with a few per cent of carbon monoxide in the exhaust. The presence of oxygen in the exhaust usually means a mixture ratio above 15 to 1 although with faulty combustion there may be some carbon

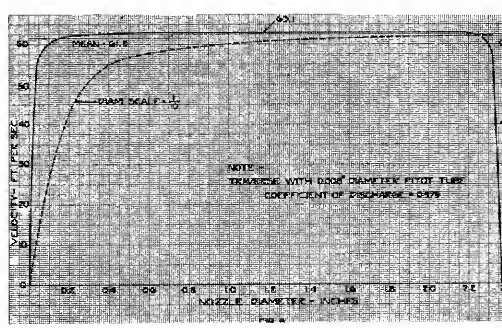


Fig. 8.

Graph Showing Velocity of Flow.

monoxide and oxygen present at the same time. Carburetor engines usually operate on the rich side of the theoretical mixture ratio regardless of the load or speed since they vary both the amount of air and fuel to meet the load demand. At idling the necessary enrichment for smooth operation may require a mixture ratio of 10 to 1 for best operating conditions.

Diesel or compression ignition engines usually operate on the lean side of the theoretical mixture ratio, and may be considered as operating "rich" when the mixture is 17 lbs. of air to one lb. of fuel. Since at any specific speed the load demand is met principally by the fuel variation (nearly constant air supply), it is obvious that mixture ratios are predominatingly lean and may be 60 lbs. of air per lb. of fuel at the lighter loads. The application of devices which examine the exhaust for combustibles is therefore usually of little value in Diesel studies. Excess air determinations or temperature measurements of the exhaust are pertinent.

Orsat

The commonly used Orsat apparatus includes, in convenient form, the necessary measuring burette and absorption pipettes so that the percentage of CO_2, O_2 and CO in the gas sample may be determined. Exhaust analysis made in this manner gives an index to the fuel and air supply which for certain inspections is adequate. Greater simplicity is obtained in some cases by determination of only one of these constituents and thereby permitting still more rapid determination or the use of continuously-indicating or recording equipment for the purpose.

The Bureau of Mines type of Orsat Apparatus gives more comprehensive data of gas analysis but also requires considerable more time and experience to operate. The sample may be analysed for

Carbon Dioxide
Illuminants
Oxygen
Hydrogen
Carbon Monoxide
Ethane
Methane
Nitrogen (by Difference)

The additional data permits a more critical inspection of engine performance but in most cases the time required does not warrant routine use of this apparatus for

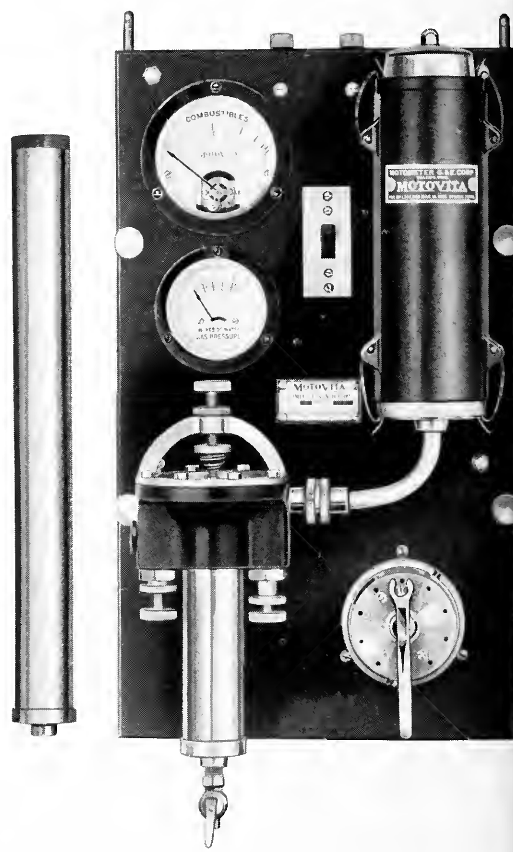


Fig. 9.

Moto Vita Combustion Indicator.

exhaust analysis. The apparatus has, however, distinct analytical advantages for certain studies. It has also distinct academic advantages for presenting a more tangible picture of combustion processes to the student. The scrutinizing of time and expense for any laboratory inspection is usually on a par with that of any industrial or production process and the routine use of this apparatus is limited to research or similar work since under best conditions it requires about two hours for an experienced operator to make one determination. It is for this reason more than any other that other methods such as the simplified Orsat or devices such as the one next described find wider application in general laboratory practice. The advisable method then is to make most inspections by a shorter method and include when necessary sufficient inspections by the longer and more comprehensive methods to guard against erroneous conclusions.

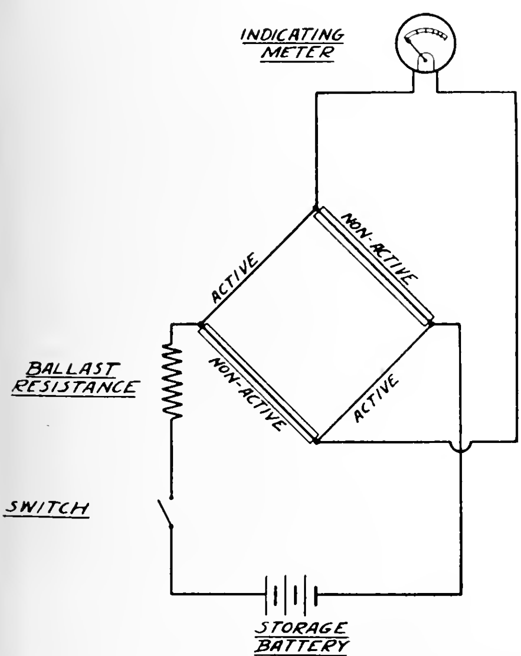


Fig. 10.

Sketch Showing Operation of Moto Vita.

One of the most conspicuous instruments of the type referred to above for facilitating rapid inspections is the Moto Vita Combustion Indicator made by the Moto Meter Gauge & Equipment Corporation. (See Fig. 9). This is designed to show the amount of combustibles in the exhaust of an internal combustion engine and thereby indicate the completeness of combustion or the approximate air-fuel ratio. The instrument in the A. I. T. laboratories has proven its usefulness in quickly indicating changes or differences of mixture ratio. It has been used with carburetor engines and gaseous fuel engines either connected with the common exhaust or with the exhausts from individual cylinders. In the first case the overall mixture ratio is indicated and in the second case, the variation in mixture between cylinders or distribution is indicated. The latter becomes a vital inspection for multiple cylinder engines, since the limits of the mixture ratio which will burn is rather narrow (approximately 9 lbs. of air to 1 lb. of petroleum of hydrocarbon fuel on the rich side to 20 to 1 on the lean side). The limits desired for satisfactory commercial operation is of course very much closer and cover approximately a change of one mixture ratio. Satisfactory commercial mixture ratios are obtainable from good commercial carburetors for steady running conditions over a wide range of loads, but this mixture is not

Moto Vita Combustion Indicator

always distributed uniformly to the various cylinders and if uniformly distributed is not always burned uniformly. Inspection of the combustible in the exhaust of the various cylinders therefore furnishes valuable data on the operating status in this respect. For work of this nature individual sampling tubes are placed as close as possible to each exhaust valve and connected by suitable piping to the multiple selector valve on the instrument. Any one of ten sampling tubes may be quickly connected to the instrument and observation made for the percent of combustibles in the exhaust. Variations in distribution are indicated in this manner and the tests show the leaner and richer cylinders. Since the operation of the Moto Vita depends upon the combustion of constituents in the exhaust, there can be no observations for mixtures leaner than the theoretical air/fuel ratio unless incomplete combustion occurs. As mentioned above, most carburetor engines are operated at slightly rich mixtures for best performance and therefore this instrument applies. Diesel or compression ignition engines however will only have combustibles in the exhaust when operating at very heavy loads or under conditions of faulty combustion. For light load conditions the air excess may be several hundred percent and no combustibles should be present.

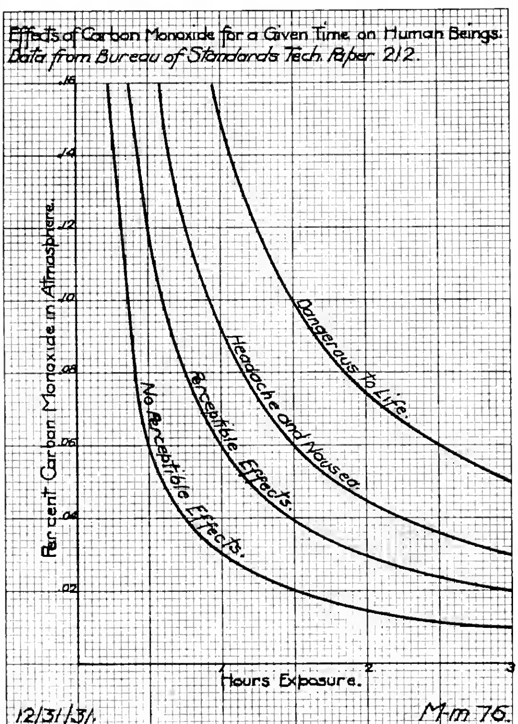


Fig. 11.

Effects of Carbon Monoxide.

For automobile service station inspection the exhaust sample is sometimes taken from the muffler tail-pipe. The instrument is suitable for car installation at least for experimental work. It has proven valuable for airplane engine installations where the information given insures definite knowledge of operating conditions and the fuel savings which are possible.

Moto Vita Operation

The Moto Vita includes a Wheatstone bridge with a galvanometer to indicate the unbalanced effect. (See Fig. 10). Two opposite arms of the bridge are of catalytically sensitive platinum wire while the other two arms are of the same material protected with fine glass capillary tubes fused to the wires to render them non-active catalytically. The bridge is operated from a storage battery to produce high enough temperatures for satisfactory catalytic action. The sample of exhaust having been previously thoroughly mixed with air at the jet and venturi throat is passed over the Wheat-

stone bridge and unbalances it when combustibles are present. The galvanometer is calibrated to read in percent combustibles in the exhaust.

Aside from the economic aspects of the presence of combustibles in the exhaust, there is also the physiological effects especially of the carbon monoxide content which presents a real hazard as indicated by the chart shown in Fig. 11. Exhaust gases from an automobile engine may have several percent of carbon monoxide which will result in dangerous concentrations unless adequate ventilation and dilution are provided. The chart from data in the Bureau of Standards Technical Paper No. 212 as given in Fig. 11 indicates a minimum requirement of less than 0.02 per cent after dilution and ventilation.

Carbon Monoxide

This is the second and concluding installment of Prof. Roesch's article, the first of which appeared in the November, 1933, issue of "The Armour Engineer."

The author wishes to acknowledge valued assistance in the preparation of drawings and in making laboratory observations, made by Messrs. P. P. Polko and E. J. Schneebalg, Senior Mechanical Engineering Students.

The Forward Flight of Aeronautics

By BARRY M. KOSTENKO

MAN has always had the desire to fly, and in recent years, after many experiments had been made and useful flying had been proved possible with the implements available, the field of aeronautics began advancing at a remarkable pace. During the past five years flying has become a common means of transportation. It has been accepted by the general public, which is always the most difficult to convince and which accepts a new development only when countless demonstrations have been made that the idea born in someone's brain is no longer an idea, but a fact proven beyond doubt. This is the final test, since, while it is comparatively simple for the person versed in aeronautical principles to accept useful flying as a fact, it is obviously far more difficult for the layman to do so. Civilian and military planes are being constantly improved. Speed, comfort, and safety are demanded by the users of this means of transportation. Public interest, added to intelligence and enthusiasm of aeronautical engineers, has made possible the airplane of today.

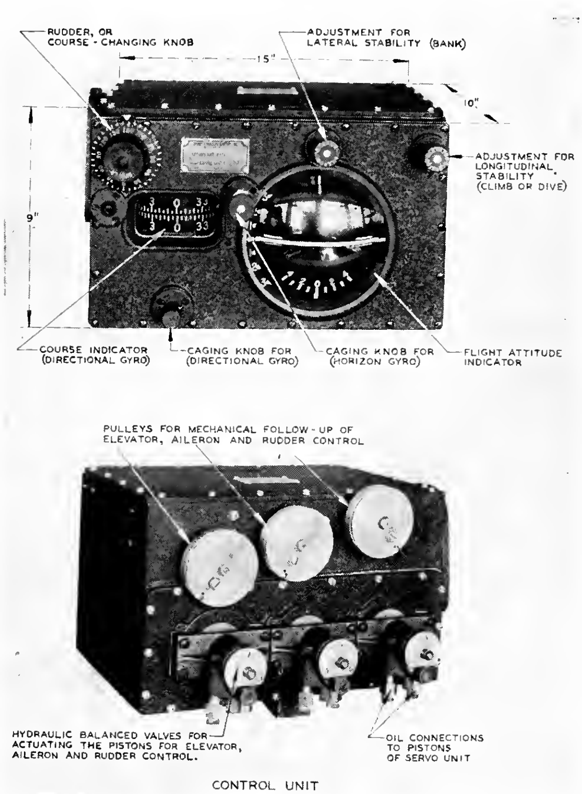


Figure 1.
General View of the "Automatic Pilot."

Automatic stability of the airplane is one of the foremost advances that have been made. Airplanes are now built with sufficient inherent stability to fly themselves in smooth air,

but it is difficult to manage a plane possessing too much inherent stability in ordinary turbulent air. The principle of the gyroscope has been used to provide automatic stability, thus making air travel more comfortable since all variations from smooth flying are quickly and safely smoothed out. The "automatic pilot," as this stability method is known, can be connected as soon as the plane has gained sufficient altitude after taking off. Maneuvers such as flat or banked turns, climbs, glides, or changes of course can be easily made by manipulating the proper control of the "automatic pilot".

To keep the airplane in level flight and on its course, it is necessary to define three fixed reference lines and convert any divergence of the airplane into corrective movements of the three controls. The reference lines are defined by two small gyroscopes A and B (Figure 2), which remain with their axles fixed in space no matter how much or in what direction their supporting frames are moved. Gyro A spins with its axle vertical. Relative movement between its axle and supporting frame longitudinally (climb or dive) is converted into corrective applications of the elevator. Relative movement laterally (wing up or down) is converted into relative applications of the ailerons. Gyro B spins with its axle horizontal. Relative movements between its axle and supporting frame in azimuth (directionally) is converted into corrective applications of the rudder. The

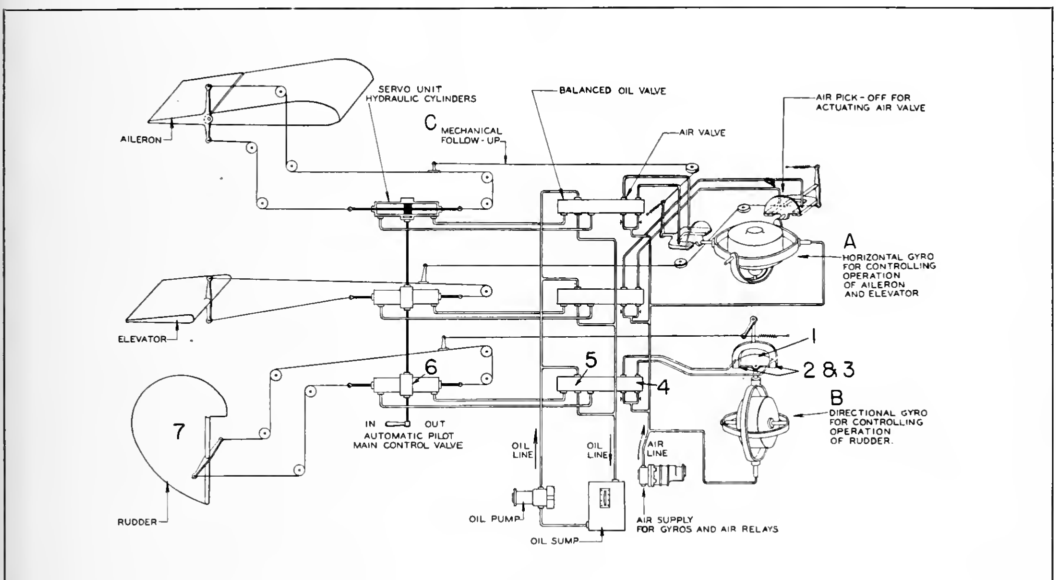


Figure 2.

Sketch Showing Operation of "Automatic Pilot."

Barry M. Kostenko is a senior student in the Department of Civil Engineering. He is Comptroller of "The Armour Engineer" and a member of Sphinx, honorary literary society.

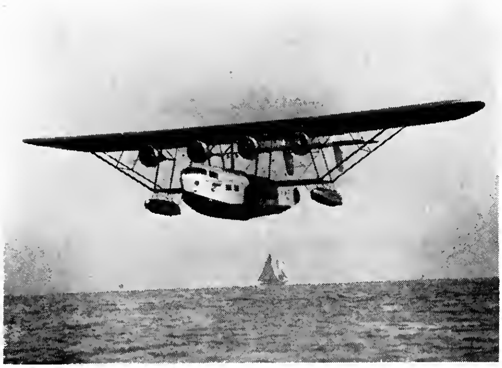
gyro, B, carries a disc 1, with knife edges which intercept an equal volume of air at each of the exhaust ports 2 and 3 as long as the airplane is exactly on its course. If the plane yaws, however, the disc remains fixed and the exhaust ports turn about a vertical axis, increasing the flow of air through one port and diminishing it through the other. This changes the pressure at the air valve, 4, actuating a balanced hydraulic valve, 5, which, in turn, moves the piston in the hydraulic servo unit, 6. The piston is mechanically connected to the rudder, 7, and moves it in the proper direction to return the airplane to its course. If the airplane yaws the other way, the action of the air pick-off, relay and servo unit is reversed and the rudder is turned in the opposite direction. Gyro A affects the same sequence of operations except that this gyro carries two discs and exhaust port systems, one of which actuates the controls for the elevator and the other for the ailerons. The air pick-off and relay system functions instantly for angular displacements of only a quarter of a degree. Since there is no actual contact between the air ports and the discs, there is no reaction of the gyros to disturb them from their fixed positions. An engine-driven air pump supplies the air for spinning the gyros and also for the air pick-off and air valve system. An engine-driven oil pump delivering three gallons per minute at 25 to 200 lbs. pressure, as required, provides the power to the pistons for the controls. The action of the hydraulic servo units is such that a large amount of corrective control is given quickly for a large departure, and a very small, slow movement for a slight departure from the course. There is no continuous oscillation, and in smooth air the controls remain almost stationary for considerable periods of time. A by-pass valve which is operated by a lever convenient to the pilot, engages or disengages the automatic control. A mechanical follow-up system, C, is employed in order to secure the proper controlling action. It is adjustable for different types of ships, and serves to prevent the over-controlling which would occur in a continuous motion system. A device is incorporated which when placed in operation will maintain flight at the desired level. The control unit, consisting of the gyros, air relays, and balanced hydraulic valves may be mounted as an integral part of the instrument board. The servo unit, consisting of the three hydraulic cylinders, is mounted in proper alignment with the control cables. The weight of the average "automatic pilot" is 60 pounds.

Using the radio as a means of communication between the ground and the plane in the air has become the means of adding more safety and convenience to air travel. With the great advances made in radio communication, the pilot is able to be in constant touch with the ground. Notices are sent out by the ground operators at frequent intervals giving weather conditions and also helping the pilot to determine his exact position with regard to any point. The pilot is also able to speak to the ground stations. "Flying blind" has ceased to be the obstacle which kept ships on the ground during a serious fog or added so much danger when a pilot had to land his plane in almost complete ig-

norance of the condition of the landing field and his relative position with regard to it. Now there is an instrument before the pilot's eyes which is controlled by radio waves sent out from the landing field. This instrument is in the form of a circular background containing a stationary and a movable set of cross-hairs, a vertical and a horizontal cross-hair in each set. This "radio compass", when turned to any broadcasting station near the objective, indicates through the simple visual-type indicator any departure to the right or left from a direct course to the objective by the movement of the movable set of cross-hairs with regard to the stationary set. Thus it remains for the pilot to manipulate the controls so as to make the two sets of cross-hairs coincide. Signals are also sent out to inform the pilot of his distance from the landing field. Thus by using the "radio compass" and the distance signals the pilot may safely land the airplane without once looking out of the plane to determine his position.

The landing and taking off of planes at airports is controlled by flashing signals, or by an operator placed at a switchboard overlooking the field. The handling of continuous traffic necessitates this centrally located control where the operator may direct traffic and outline the airport for incoming planes, thereby promoting safety and helping the aviator. With this centralized control, all lighting equipment is directed by the dispatcher in the observation room. There a control desk is equipped with a complete outline of the field with pilot lamps marking the beacons, markers, and signal lamps. A compass and wind indicator also aid the operator in directing planes. The electrical circuits are so arranged that each landing direction is automatically indicated by the rows of lights on each side of the runway.

Methods of reducing the weights and resistances of the various parts of the airship have not been neglected. The modern tendency is toward an all-metal plane. Duralumin, which combines the lightness of aluminum with the strength of steel, is composed of ninety-four per cent aluminum with small quantities of copper, manganese, and magnesium. It is fast gaining an important place as construction material for the airship. Its weight is about one-third that of steel. Berrylium-aluminum alloys have also attracted attention in this connection. To reduce air resistance disappearing landing gear has been constructed on some airplanes. Methods of making certain that the landing gear is in proper place when landing is incorporated into the construction. Due to the increased demand for speed all possible sources of air resistance are being investigated to help in reducing these retarding forces on the airplane in flight. The possibility of flying at high altitudes is coming to the fore. The reduced density and the smoothness of the air at high altitudes is leading to probable use in the future of the high altitude strata as lanes for airplane traffic. The drop in temperature and the detrimental effects upon the human system as well as upon the operation of the engine are great obstacles which are being studied with a view to eliminating them and thus making such transportation possible on a large scale.



Modern Amphibian.

Three years ago the autogiro was introduced into America. Since then it has become increasingly popular. The fact that it can take-off and land within a small land area is a great factor in its favor. It has stood up under all kinds of flying conditions. Serious consideration is being given to the idea of using the autogiro in time of war as a part of the military organization. The fact that it can remain stationary, except for air movements, makes it possible for it to enter war zones, make observations including photographs, and in case it is attacked, to defend itself, which was impossible in the case of the observation balloons used during the World War which were dependent upon escorting aircraft for protection and who were absolutely helpless if caught alone by the enemy.

Heating and ventilation have not been neglected in the development of the modern transport airplane. A new system has been developed for heating the air, cooling the air, and exhausting the foul and hot gases. Fresh air is taken in at the edge of the lower wing and passed over a chamber, where it is heated by the exhaust and is then carried to individual outlets at each passenger seat, thus making it possible for the passenger to regulate the heat coming to his seat. The pilot's cabin is heated by the heater connected to the central motor. The cool air system is installed in the leading edge of the wing and the air is conveyed through individual vents which may be controlled by the passenger. The exhaust unit is located in the ceiling of the cabin and foul air is sucked through a specially designed venturi. An indicator on the instrument board tells the pilot of the condition of the air in the cabin and, since the entire system is under his control, he is able to regulate the action of the ventilating and heating system.

"Different" types of airplanes are constantly being built and tested. To mention one of the recent types that have been built, there is the paddle-wing plane. Each wing of this plane carries four paddles or airfoils in a quadrant which is made to revolve about a lateral axis by a motor. The leading edges of the foils follow the trailing edges. These airfoils are shaped like the ordinary airplane wing, and consequently, any one is capable of creating a lift in any position of rotation, provided that its angle of attack is of the proper value. To vary the angle of attack of the foil, a cam and lever mechanism is used in conjunction with the motor. As the wings revolve, the foils are automatically adjusted as to pitch so that the foil momentarily at the top exerts a strong pull upward, the foil at the front pulls forward, the foil at the bottom pulls weakly upward, and the foil at the back remains

virtually neutral. For flights in a horizontal direction the cam fixes the angles of attack of the forward and rear foils so that the lift is applied horizontally. Thus the ship may be "braked" by reversing the lift of the airfoil. The pilot can control the pitch of the foils to regulate the speed and direction of flight, and in case the motor stops the foils automatically assumed the position for vertical descent which it is able to do at any desired speed. The plane can remain stationary in the air for an indefinite period. It can turn around on its own axis. The revolving wing idea is not entirely new for it is very similar to the Worth-Schneider propeller for boats. Many of these "new" types of airplanes fail, but a few ideas survive and are either built according to the original design or are incorporated into an existing type of airplane.

There have been many other developments which cannot be mentioned in a short article. The field of aeronautics has made such tremendous progress in such a short time that it is fascinating to contemplate what further advances are going to be made in the next few years. The youngest form of transportation, and one of the oldest wishes of the human race, has gone far and time to work out the ideas which are even now being brought forward will reveal to what extent aeronautics will advance.

The Necessity of Exercise in Education

By PROF. JOHN J. SCHOMMER

IN THE last twelve years a number of well meaning and patriotic individuals have delivered Armistice Day addresses to college students. In most of these talks reference has been made to the utter lack of physical fitness on the part of the American youth who fought in the World War. Solicitous advice was given to train physically and be well prepared to fight in the next war.

That the contention about physical fitness of the American boys was largely correct is shown by the statistics in the following table compiled during the American draft for the World's War.

American Draft Ages 21 to 31 inclusive	40% Physically Fit 40% In Dire Need of Training 20% Totally Unfit

Between the ages of 21 to 31 the male should be at the very height of his physical capabilities, yet flat feet, broken arches, spinal curvatures, underweight, under physical development, and venereal diseases rendered 60% of America's youth unfit.

These facts greatly aroused educational circles and much was done to correct many of the defects of the young men of America. Extensive programs for physical welfare were inaugurated in high schools and colleges. To these was enlisted, throughout the country, the civic playground with its gymnasium and thoroughly supervised course of instruction in games and corrective exercises.

In the last three years budgets had to be slashed in cities, high schools, and universities, and so physical education was drastically curtailed and in many cases entirely eliminated.

Physical education with its corrective

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gymnasium exercises, intramural sports, and competitive athletics is as essential in a well balanced curriculum as any other subject. Most of our noted psychologists —Kirkpatrick, King, Thorndyke, James, Whitley, McDougall—say that education is improving human nature and human nature is composed of certain natural instincts, certain natural tendencies and capacities possessed by every growing child. Among these tendencies Health is listed first or second in every case. Health may be best attained and kept by regular exercise. This may be either corrective gymnasium work to overcome certain physical defects or competitive games—the safety valve of the nation. Play aids in the prevention of mental diseases by relieving the pressure on the mind so stressed by the many problems of the modern complex life. Play tires the body and so induces sleep so necessary for one's battery of nerves. Every student and alumnus should learn to play some competitive game such as handball, tennis, golf, or squash. These games should be indulged in at least twice a week, particularly so in all cases where no physical exertion wets the sweat pores during the course of one's daily work. The student, of course, has access to the gymnasium, swimming pool, and competitive athletics, but it is to be hoped that there will be a day when every student, before he may receive his degree, must be able to swim, play handball, tennis, golf, or squash, and that the facilities are at hand to accord these privileges. The competitive games, such as baseball, track, foot ball, and basketball are seldom indulged in after graduation from college.

These exercises and games are not to keep one fit for war, but rather to keep one fit for the battles of life. These games and exercises are not to make a prize fighter or a wrestler of one nor to create an Apollo, but to build up reserve strength and energy necessary for success and happiness in this life. In this combative industrial strife one must keep physically fit to house a sound mind. Don't neglect your exercise and don't forget to do it with play.

THE ARMOUR ENGINEER

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Idealism

THE engineering profession has as its foundation a paradoxical base, idealism. The marvelous attainments of this calling would not have arisen to such great heights, were it not for the dissatisfaction of its members, the inherent desire to create things as they should be, not as they are. Without this desire to rise above commonplace life, this idealism, man would lead but an animal existence.

Idealism has always been regarded as the privilege of youth. As future leaders of civilization, as engineers, and as men, we must grasp this life belt of idealism and cling to it lest we be dragged into the

sea of despair. Although existing circumstances may weaken one's hold, this preserver will develop greater vision as engineers and greater happiness as inhabitants on this strange earth of ours.

N. U.-U of C. Merger and Armour

WHILE the Northwestern University-University of Chicago merger is apparently not in such an advanced stage as to warrant statements as to its merits or defects, it is of sufficient importance to comment as to its possible effects on education in Chicago, particularly that branch with which Armour Institute is interested.

If the consolidation is effected, Chicago will undoubtedly be reputed as one of the most important educational centers in the United States. Not only will the facilities of these two great institutions be utilized to further undergraduate work, but advanced studies will play an important part.

The question now arises as to how Armour will be effected by this merger. For the past forty years Armour has held a leading place in engineering education in this country. Its high standing is well known. It is almost a certainty that, with the U. of C.-N. U. merger, the efforts of these two schools will be bent toward the improvement of their engineering course. Just what effects this will have upon Armour, and just what part will Armour play in this development, will have to be observed as time progresses. We hope it will be an active part, and one which will preserve the good name of Armour Institute of Technology.

THE GUEST EDITORIAL

Human Engineering

THE railroads of the United States represent an investment of about twenty-six billion dollars, and their employes number more than one million. Thus for each employe, on the average, there are provided tools worth roundly $25,000.

These tools cover a great range of cost and complexity, and many of them are marvels of engineering. Time, care and expense go into their making and maintenance. Yet they are of little value except as they are expertly handled—indeed, if inexpertly handled they may be destructive of life and property.

These facts constitute a challenge to engineering genius. It is not enough to plan and build and improve the machinery of our civilization. Human engineering is needed as well.

The technically trained man aspiring to a well-rounded career must be able to teach, to inspire, to arouse in his associates the "last, full measure" of devotion which is essential to the ultimate success of the enterprise in which they are engaged.

—Lawrence A. Downs

President
Illinois Central Railroad.

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

Theory of Dielectrics

By A. Schwaiger
Translated by R. W. Sorensen
Wiley, $6.50

THE growth of centralized electrical energy generation has been brought about by economic considerations. This has necessitated long distance transmission of power which has resulted in the use of high voltages as a means of transmitting the power efficiently.

High voltages involve the use of insulating materials and since, in the interests of economy, these materials should be well utilized, a knowledge of dielectrics is very essential in the design of transmission lines.

This book is designed so that it is serviceable as a textbook on the science of dielectrics, giving an understandable and comprehensive analysis of the subject.

Many of the calculations used in designing various transmission constructions are large time consumers. This book contains methods of calculation whereby these long formulas are reduced to practical forms by use of so-called utilization factors.

"The book is divided into three parts; the first is devoted to puncture, the second to arc-over, and the third to describing the practical applications of high voltage technique." While no new theory is advanced in the first part, the second part is almost entirely original since we find here an attempt to calculate flash-over. The practical man should find the third part interesting because it is based upon tests made by various firms and manufacturers.

The Technical Arts and Sciences of the Ancients

By Albert Neuburger
Translated by Henry L. Brose, M. A., D. Phil.

MODERN man has always been amazed by some of the marvelous achievements of the ancients. The pyramids, the sphinxes, the beautiful temples have all been acclaimed as stupendous engineering feats, and many have stated that even with modern equipment and knowledge, engineers of today would encounter almost unsurmountable difficulties should they attempt to construct a monument such as the Great Sphinx at Gezeh, or the Great Pyramid of Cheops. These and other remarkable achievements seem to indicate that the ancients were in possession of knowledge that has since become lost to us.

Although certain isolated facts concerning the technical sciences of the ancients have reached us, a complete treatise on the subject has never been written before. The author of this work was occupied for over twenty years collecting and sifting the facts which he considered necessary for an

adequate survey of this most interesting subject.

The work begins with mining, one of the fundamentals of the technical sciences. We are then introduced to the metallurgy of the ancients. Certain metallic articles left us by antiquity seem to indicate that they were acquainted with properties of metal of which we today have not the slightest knowledge. We are shown their agriculture, their methods of preservation, with interesting data on mummies, their adeptness in the ceramic art, in weaving, and their technique in painting. Of particular interest to the civil and architectural engineers are chapters on town planning, fortifications, water supply, drainage systems, roads, and bridges.

The book as a whole establishes a hypothesis advanced by a number of people to explain, in part, the wonders of the ancients. Although their knowledge was limited, they penetrated deeply and exhausted every possibility. They thus contrast with our age where broad fields with multitudes of diverse subjects are covered, only to be left before all of the benefits possible have been reaped.

Smoke

By R. Whytlaw-Gray and H. S. Patterson
London E. Arnold & Co. (1932) $4.50

SMOKE control has proved to be a serious problem for industrial centers. The harms caused by a smoke-polluted atmosphere are numerous and warrant an intense campaign for their abolition. Much attention has been directed to practical problems dealing with smoke but few attempts have been made to explain the behavior of smoke in terms of general principles.

This book is concerned with a scientific study of smoke. No attempt is made to apply the theoretical conclusions to practical problems. However, a knowledge of the fundamentals of smoke behavior should prove valuable in the answering of many technical questions.

Among the subjects discussed are the following: present methods of counting particles, the theory of coagulation, the structure of smoke particles, the determination of weight concentration, the scattering of light by smokes, and the electrification of smoke particles.

This book would possess little interest for the casual reader because of the fact that it is directed towards the solution of involved theoretical problems.

Deep Borehole Surveys and Problems

By M. H. Haddock
New York, McGraw-Hill (1931) $4.00

IT IS generally agreed that no deep borehole has been bored that did not deviate from its intended direction. Consequently, a large amount of trouble and litigation has been incurred by borehole projects.

Many ingenious instruments have been devised to survey a borehole by determining its length and deviation. This book traces the evolution of these modern borehole-surveying devices. The various methods are classified and described with the aid of many illustrations. These classifications include the following: fluid meth-

ods, compass and plumb-bob methods, pendulum methods, photographic methods, and gyroscopic compass methods. Geophysical methods of investigating boreholes are described and problems relevant to strata location and orientation are added.

The Automatic Stabilization of Ships

By T. W. Chalmers
London, Chapman & Hall (1931) $4.50

AUTOMATIC stabilization has as its objective, the reduction or elimination of the motion imparted to a vessel by waves and is usually designed to reduce or eliminate rolling motion.

In the case of the passenger liner, the promotion of comfort is of primary importance. The elimination of the rolling motion of a ship accomplishes much in the attempt to prevent sea-sickness and thus warrants the additional expense needed to equip a ship with stabilizing equipment. The prevention of sea-sickness is not the sole object of automatic stabilization. Contrary to popular belief, a stabilized vessel is subject to less stress in its hull than an unstabilized vessel. Better speed and less fuel consumption in a rough sea are made possible by the addition of stabilizing equipment and the possibility of foundering is of course reduced considerably.

This book is devoted to the two main systems of stabilization, namely, the Frahm anti-rolling system and the gyroscopic system. The latter heading includes descriptions of the Schlick system, the Sperry system, the twin gyroscopic system and the Fieux system. The theory involved in the various types of automatic stabilization is presented in terms which should appeal to those who are not expert mathematicians. The fundamental theory of the gyroscope appropriately precedes the descriptions of the various applied methods of automatic stabilization.

THE COLLEGE CHRONICLE

NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Basketball

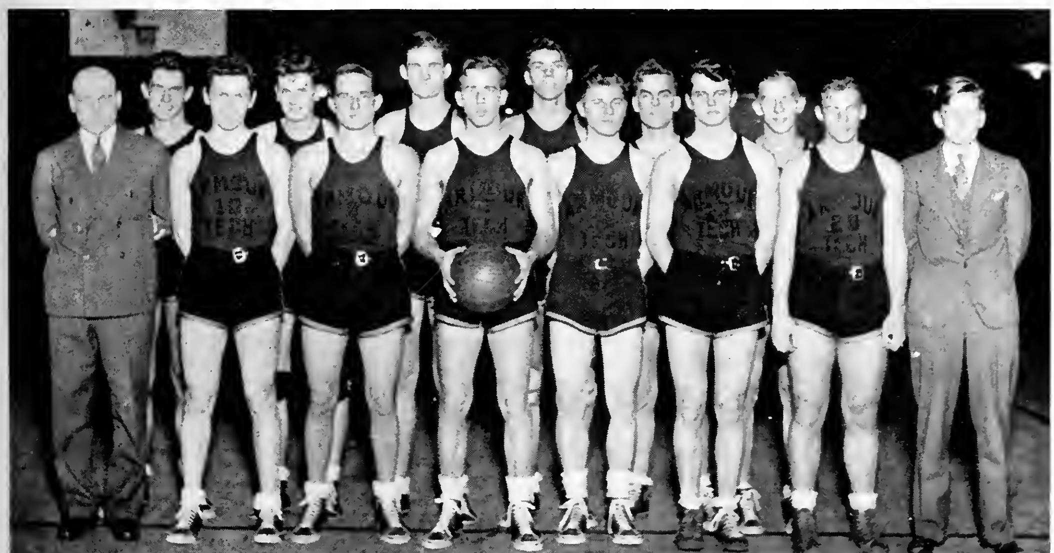
FROM all appearances the Armour basketball team will have one of its most successful seasons. Captain Ray Pflum, who has been out of the earlier games because of injuries, has rejoined his mates. The freshmen have strengthened the team a great deal.

The team has thus far won two games and lost one, winning from George Williams College and the University of Chicago and losing to North Central.

Boxing and Wrestling

AFTER scoring a win over West Side "Y," Tech's wrestlers are eager to continue with a "no defeat" season. Led by Captain Talaber, who defeated Bill Redman, the "Y" coach and former Big Ten champion, the team bested "Y" to the merry tune of 5 to 3.

On the same evening our gentlemen leather pushers lost their mix, but this only serves as a spur which is goading them on to a sure win in their next meet.



Photograph by Bard.

ARMOUR'S BASKETBALL TEAM

First row, left to right—Krafft, coach, Levy, Rummel, Pflum, cap't, Sremek, Dollenmaier, Olson, Davidson, mgr.

Second row—Lukas, Heike, Lauchiskis, Merz, Warner, Christoph.

Armour's Faculty and Trustees were entertained by a wrestling and boxing show staged as part of the Christmas banquet program. The wrestling was a bout between Captain Talaber and Herman Sumner. The audience was thrilled by the various holds and the efforts of the wrestlers. As the boxing performance, Glen Graham and Richard Wey fought the first bout of the annual school tournament.

Honor A

THE Honor A Society, an organization consisting of the outstanding athletes of the school, has decided no longer to admit sports managers. In this way they hope to bring the membership down to about twenty men. The latest newcomers to the society are Ray Pflum, Basketball; George Mayer, Baseball; John Ahern, Swimming; Richard Armsbury, Tennis; and Frank Talaber, Wrestling.

Track

TRACK practice is progressing uniformly at Bartlett Gym with approximately thirty aspirants training during their open hours. The gym is open at all times and lockers are assigned after students have qualified for the team.

Regular practice is necessary to develop the form that is essential in track. Only men showing interest and ability are kept on the squad.

Invitations have been sent to the teams of various colleges, but as yet no complete schedule has been made. The schedule will be announced in the near future.

Swimming

THE time trials held at the University of Chicago on December 5, 1933, indicated that several of the new men trying out for swimming are very promising material. Two of these men, Leonard Dworsky and Herbert Ruekberg, did especially well. The veterans also showed up as well as might be expected so early in the season.

Manager Robert W. Suman has worked hard on the schedule. He has arranged several out-of-town meets, including some with Big Ten schools. It is probable that Armour will do well in all of these meets because only two men were lost through graduation last year.

Interhonorary Banquet

THE annual interhonorary banquet was held on December 20th at the Medinah Athletic Club. This is one of the two affairs given every year by the Interhonorary Council, the attendance being restricted to members of honoraries.

The new members of the groups were introduced to the gathering by the presidents of their respective societies. The principal speaker of the evening was Edgar S. Nethercut, the executive secretary of the Western Society of Engineers. Dean Heald acted as toastmaster for the banquet, and short talks were given by President Hotchkiss and Dean Penn.

Tau Beta Pi

RUSSELL R. JOHNSON, sophomore Civil, who had the highest scholarship average in the freshman class last year, has been awarded the Tau Beta Pi prize of a subscription to a technical magazine. Russell's choice was "Civil Engineering."

Pi Tau Sigma

THE honorary mechanical engineering fraternity is now firmly entrenched in its new rooms, located at 41 E. 33rd St. The rooms were put in order only after hours of assiduous labor with respect to cleaning and painting by the individual members, coupled with considerable moving of pieces of furniture from building to building.

Eta Kappa Nu

THE following pledges were initiated on November 17, 1933, in the presence of the past actives and Professor Ernest H. Freeman:

Seniors—

Glenn F. Graham.
William W. Laemmer.
Elmer G. Lundin.
Thomas F. Murphy.
John T. Paslawsky.

Juniors—

William B. Ahern.
Arling M. Wolf.
Donald E. Young.

A celebration was held the same evening at the Bismarck Hotel, Walnut Room, Ted Weems' music.

The keys were presented at the A. I. E. E. smoker on November 23rd at the Theta Xi House.

At the smoker the fraternity also presented the yearly prize of an engraved Electrical Engineer's Handbook to the winner of the sophomore electrical essay contest. The winner was Leo. C. Galbraith.

The officers are:

Paul J. Thompson, President.
Stephen G. Lehmann, Vice-President.
Elmer G. Lundin, Secretary.
Glenn F. Graham, Treasurer.
Wm. W. Laemmer, Corresp.-Secretary.
S. G. Lehmann, Bridge Editor.

Phi Lambda Upsilon

THE four men who were pledged by Phi Lambda Upsilon, Armour's honorary chemical engineering fraternity, on November 23, 1933, will be initiated early next semester. They are:

Richard D. Armsbury, '35.
Alfred F. Kapecki, '34.
Elmer P. Renstrom, '35.
Jack N. Weiland, '34.

The men were chosen for their personality and their scholarship. Several alumni were present at the pledging to inspect the neophytes.

Salamander

C. P. KUFFEL, '34, and E. N. Searl, '35, were formally initiated into Salamander, honorary fire protection engineering fraternity, on Thursday evening, November 9, at the Phi Kappa Sigma house. In addition to the active members, several honorary and alumni members were present.

The inter-honorary banquet, held December 20, was well attended by Salamander members.

Chi Epsilon

NINE new men were initiated into the honorary civil engineering fraternity on December 18, 1933, at a meeting held in the Chi Epsilon quarters in Chapin Hall. The honored men are:

Harold W. A. Davidson, '34.
Raymond A. Fleissner, '34.
Edwin G. Hoffmann, '34.
Albert C. Ketler, '34.
Leonard Marcus, '34.
Raymond J. Pflum, '34.
Otto Schmidt, '34.
Eric H. Smith, '34.
Kenneth O. Stocking, '35.

After the formal initiation, a social gathering was held. This party finally ended up at the Palmer House.

Pi Nu Epsilon

THE honorary musical fraternity held its formal initiation on December 7, 1933. The men admitted into the fraternity at that time were:

Charles A. Cunningham, '34.
Ronald P. Dobson, '34.
Raymond A. Fleissner, '34.
Alexander Kulpak, '35.
J. Russell Lang, '35.
Walter A. Sobel, '35.
Stanley G. Viktora, '35.
Harvey A. Williams, '34.

After the proceedings were over, everyone went to the Garrick Theatre to see "Bartered Bride."

The officers of the fraternity for the current year are:

John L. Brenner, President.
Clarence W. Clarkson, Vice-President.
Edward G. Avery, Secretary-Treasurer.

American Society of Mechanical Engineers

THE present officers of the A. S. M. E. are:

Robert W. Suman, President.
John B. Lukey, Treasurer.
Irving A. Kolve, Secretary.
Prof. J. C. Peebles, Honorary Chairman.

Meetings of the society have been held every two weeks, and several very interesting speakers have attended them. Among the most notable speakers were Mr. R. O. Butterfield from the Vacuum Oil Company, Mr. Laron Gayton from the City Engineering Company, Mr. Herbert M. Short from McIntosh and Seymour, Diesel Engine Manufacturers, and Dr. Gustav Egloff from Universal Oil Products. Plans are being made to have films shown at some of the future meetings.

The largest attendance on record turned out for the last smoker, held at the Triangle Fraternity house. There were sixty members and eight professors present. Everyone enjoyed himself, especially with the mountains of food and numerous smokes available.

Since Professor Peebles has had charge of the membership drive, the society has had the largest roll in its history. The activity of the other officers is indicated by their plans for an inspection trip in the near future.

Fire Protection Engineering Society

AMONG the recent speakers at the bi-weekly meetings of the Fire Protection Engineering Society were Chief McAuliffe of the Chicago Fire Insurance Patrol, Mr. Miller, manager of the Illinois

Audit Bureau, and Mr. Baker, chief engineer of the Insurance Company of North America. Chief McAuliffe spoke on the "Insurance Patrol and Its Functions"; Mr. Miller explained the functions and operating principles of the Audit Bureau to the members of the society. Mr. Baker gave a talk on "Mutual and Reciprocal Competition", discussing the kind of competition with which a stock fire insurance company must cope.

Other Chicago men prominent in the fields of insurance and fire protection are to be engaged for future meetings of the society.

Sphinx

ARMOUR'S honorary literary fraternity announces the initiation of the following men:

W. A. Hoyer, '34.
B. M. Kostenko, '34.
P. P. Polko, '34.
J. E. Schreiner, '34.
E. A. Svoboda, '34.
H. J. Zibble, '35.
Professor W. W. Colvert.
Professor E. C. Grafton.

With increased membership, plans have been made to enlarge the year's activities.

Western Society of Engineers

AT THE last smoker, which was held in the Triangle house on November 17, 1933, entertainment was provided by the Chi Epsilon pledges. They presented three very interesting plays.

Some of the noteworthy speakers who have met with the society in the past few months are Mr. Rush from R. W. Hunt, Engineering Consultants, Mr. Bordon from the American Bridge and Iron Works, Mr. T. L. Condon from Condon & Post, and Mr. Henry Penn from the American Institute of Steel Construction. The last is the brother of Dean Penn.

American Institute of Chemical Engineers

THE Christmas smoker held on December 29, 1933, missed Santa Claus by four days. Nevertheless, everyone enjoyed the evening, which was spent in relating what the old gentleman had deposited at the homes of the various members. The gathering place was the Truss Club rooms.

Two notable speakers have been obtained for this month. The first, Dr. G. J. Fink of the National Aluminate Corporation, will give a talk on "Water Softening," January 12. The second, Dr. C. C. Monrad from the Standard Oil Company of Indiana, will discuss "Heat Transfer," on January 19.

Alpha Chi Sigma

ALPHA Psi chapter of Alpha Chi Sigma, national professional chemical fraternity, pledged the following men October 30, 1933, in the fraternity rooms:

Charles T. Clark, '36.
Harry G. Gragg, '36.
Howard P. Milleville, '36.
Robert M. Paulson, '36.
Robert C. Peterson, '36.
Algird Rulis, '36.

The initiation of these pledges will be held in March.

On November 5, 1933, a tri-chapter banquet was held by the men from Armour, Northwestern, and Chicago at the Chicago Engineers Club.

The third birthday of Alpha Psi was celebrated on December 16, 1933, by the annual party held at the home of Reynold Steinert, '32. Dancing and card playing were the chief diversions of the twenty couples who attended the party. Mr. Van Dorn, of the Central Scientific Company, district counsellor of the fraternity, was among the honored guests present.

Four of the alumni members, Russell H. Blom, Walter G. Hollman, Altus M. Ream, and Gervase J. Stockman, are back at school taking graduate work. The majority of the remaining alumni have found positions and are busy at work.

The chapter will send one of its members as a delegate to the Alpha Chi Sigma convention to be held at Indianapolis.

ALUMNI NOTES

NEWS OF ARMOUR ALUMNI ASSOCIATION AND OF ARMOUR GRADUATES

ALUMNI, this is your section. A certain number of pages are set aside each issue exclusively for alumni news. We want to please you and print the type of material you desire, but to do this we *must* have your cooperation in securing news. Any alumni news you might hear, kindly pass it on to us, and we shall be glad to print it. Remember, we are depending on you to keep up your section of The Armour Engineer.

New Trustees Elected

AT A business meeting on November 14th of the officers of the Armour Institute of Technology Alumni Association the power was given the President, John J. Schommer, to select a committee to consider prominent alumni for trustees of Armour Institute. As a result of this action, the following three men were elected to sit on the board:

Alfred L. Eustice
Edwin O. Griffenhagen
Howard L. Krum

The terms these trustees will sit on the board are one year, two years, and three years, respectively, in the order named above.

All three of these men are alumni of Armour. Mr. Eustice received his B. S. degree in Electrical Engineering in 1907 and his E. E. degree in 1910. At present he is President of the Economy Fuse & Manufacturing Company of Chicago. He has always been extremely active in alumni affairs, and was host at his farm near Chicago to the twenty-fifth reunion of his class in June, 1932.

Mr. Griffenhagen is a senior partner of Edwin O. Griffenhagen and Associates of Chicago. He received his B. S. degree in Civil Engineering in 1906 and his C. E. degree in 1909. His company has been instrumental in many governmental changes, both in this country and in Canada.

Mr. Krum received his B. S. degree in Electrical Engineering in 1906 and his E. E. degree in 1911. He is Vice-President of the Teletype Company of Chicago, and was responsible for the origin and development of instruments made by the Teletype Company, for which work he was given the Armour Alumni Association Distinguished Award in June, 1932.

Trustee Passes Away

LESTER L. FALK, trustee of Armour Institute of Technology and prominent Chicago attorney, passed away on November 22nd, the result of a cerebral hemorrhage.

Mr. Falk attended the Armour Academy between the years 1898 and 1902, and later took his degrees from Brown University and Harvard.

He was admitted to the bar in 1909, and, at the time of his death, was a member of the law firm of Scott, MacLeish & Falk.

Armour Alumnus Aids Science

THE theory that the speed of light is variable, and not constant, as has heretofore been acknowledged, has been advanced as a result of experiments performed by Dr. Francis G. Pease, E. E., '01, and co-workers at Mount Wilson Observatory, Pasadena, Calif. Dr. Pease, working for the Carnegie Institution of Washington, has been continuing the experiments of Dr. A. Michelson, prominent physicist of the University of Chicago. This variable speed theory, in which the speed is said to be cyclic, may be of such importance as to affect the conclusions of Einstein's Theory.

Dr. Pease may be remembered as receiving the first award given by the Armour Alumni Association for outstanding alumni. He had previously secured renown because of his design of a 200-inch reflector for a telescope.

The bi-annual alumni smoker was held on December 26th at the University Club of Chicago, at 6:00 P. M. The smoker was attended by a large number of alumni, who renewed old acquaintances and recalled interesting experiences of their undergraduate days.

Personals

M. A. Smith, Jr., '10, of the U. S. Gypsum Company, has been appointed chairman of the Industrial Relations Committee. This committee will cooperate with the Placement Department at Armour in its contacts with industries of Chicago and in the placement of graduates.

Capt. Charles L. Bolte, '17, is stationed with the U. S. Army at Tientsin, China.

William W. Pearce, '21, is now connected with the water and power department of the City of Los Angeles, California.

John B. Allen, '23, who has been engaged in the building and architecture of the Presbyterian missions in Cameron, West Africa, died on October 1st, 1932.

John Kramer, '23, is at present holding a position with the Starrett Manufacturing Company, Chicago.

John H. Sweeney, '24, is now in the insurance business with W. A. Alexander and Company.

Von Donald Taylor, '25, was killed in an accident on March 18, 1933. Mr. Taylor was a graduate of the department of Fire Protection Engineering.

Gustave G. Erland, '30, formerly with the Illinois Steel Company, is now connected with the office of Albert J. Fihe, patent attorney.

Alvin E. Auerbach, C. E., '31, is now a junior engineer for the government. He is stationed at Rock Island, Illinois.

Frank James is working with the Kentucky Actuarial Bureau, Paducah, Kentucky.

Frank Podlipec, '31, has accepted a position with the Richman Chemical Company.

According to John J. Schommer, Mr. A. Corman, of the National Radio Co., caught a lot of bass this summer in northern Minnesota. But once on the subject of bass, Professor Schommer immediately launched on the goodly quantity of bass and muskies he caught during the summer, so we heard no more of Mr. Corman.

Roger F. Waindle, '32, is now situated with the Johnson Company, wholesalers of ventilating equipment.

Peter Venema, '32, is with the Reliance Dental Manufacturing Company.

Marshall R. Beal, '32, is with the Indiana Inspection Bureau.

John R. McLane, '33, now has a position with Libby-McNeill-Libby.

Harry C. Nissen, '28, is still located with Berlinger Joyce Aircraft Corporation.

Richard G. Osgood, '27, is with the Insurance Company of North America.

Glenn W. Schodde, '32, is with the Iowa Inspection Bureau, Des Moines, Iowa.

Frank A. Utrask is located with Swain, Nelson and Sons Landscaping Company.

R. H. Bates, '28, is in the employ of the Standard Oil Company at Whitehall, Illinois.

Harvey C. Rossing, '32, is working for the E. J. Brach Candy Company.

ALUMNI . . .

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TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF AUTHORS AND PUBLISHERS

Ter Meulen Method for Direct Determination of Oxygen in Organic Compounds

By W. Walker Russell and John W. Fulton, Brown University

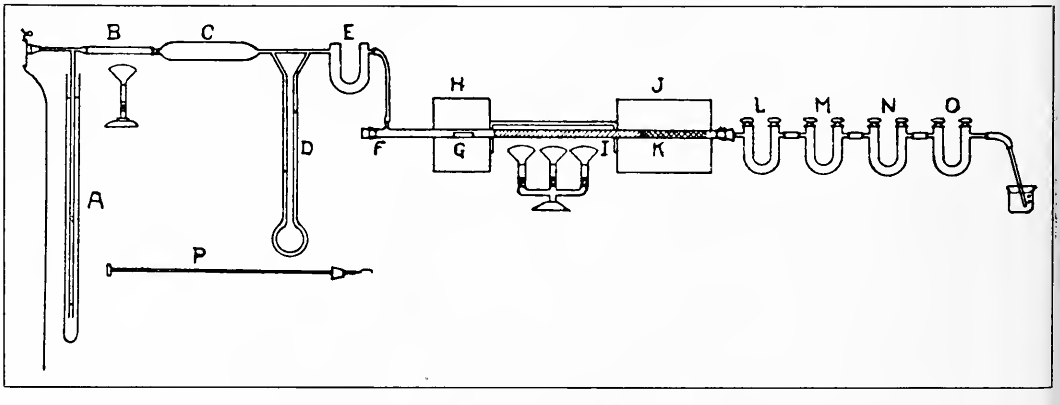
(From Industrial and Engineering Chemistry, November 15, 1933)

OXYGEN in organic compounds is usually determined quantitatively by the indirect method of determining differences in gross weights and constituent weights. This indirect method is too conducive to error, however, and methods of direct determination have been studied for almost a century. Of these the plan of Ter Meulen, a German chemist, is of great interest.

His method, in brief, consists of vaporizing the organic compound in a stream of hydrogen flowing over a red hot surface on which the sample has been decomposed. Oxides of carbon and water, and gaseous hydrocarbons are formed, and pass over a nickel catalyst where the oxides of carbon are converted to methane and water. Means of evaluating water and any escaping carbon dioxide give data for the calculation of oxygen in the sample.

An electric furnace used to volatilize the sample does the work quickly and easily. An effective catalyst is prepared by dissolving enough thorium nitrate in nickel nitrate to give two percent thorium oxide on the nickel and stirred into a fine powder while being ignited over a Bunsen burner.

Hydrogen is admitted to the system at the entrance on the left, passed over hot palladized asbestos at B to free it of oxygen, and dried over calcium chloride in C and E, after having been measured by the flowmeter at D it passes over the heating surface at K, in the furnace J. This heating surface consists of twenty mesh quartz,



Sketch Showing Ter Meulen Method.

ammonium chloride, and a platinum choride solution. After the system is flushed with hydrogen, the stream is turned off into tube A, and the sample to be reduced is inserted at F by means of the rod P. It is volatilized in furnace H at a slow heat, and after about a half hour the furnace is removed and on the sample is directed the full flame of a blow torch. A half hour is then spent in thoroughly conducting the oxide gasses through the system by means of the hydrogen stream, introduced at about 90 c. c. per minute.

The experiment terminates in the U tubes at the right. They have been filled with calcium chloride before the performance of the experiment, and weighed. If the work is properly done, all the oxygen will be found as water in tube L. The other tubes are used as guards against the escape of any water. There is a quantity of ascarite in tube N with the calcium chloride.

Seventeen tests of the ter Meulen method involving eight substances yielded results within seven tenths of one percent of the calculated amount of oxygen, a sufficient proof of the practicability of the experiment.

Budd Completes First "New Deal" Gasoline Railroad Train

(From Iron Age, November 9, 1933, page 25)

THE E. G. Budd Mfg. Co., of Philadelphia has completed for the Texas & Pacific Railroad, a two-car stainless steel "shot-welded" air-conditioned rubber tired, gasoline driven train.

It will provide 50% more speed than the two-car steam train it is replacing, with one-fifth of the horsepower and one-sixth of the weight at one-half of the operating cost. The train weighs 100,000 pounds against 600,000 pounds for a steam driven train and locomotive of similar capacity.

It makes a maximum of 75 miles an hour, and has luxurious seating and baggage accommodations for 76 passengers, separate compartments and toilet facilities for white and colored travelers and the first standard railway postal compartment translated into stainless steel ever authorized by the U. S. Postal Department.

The two cars are very different in construction and purpose. The forward, or operating car, carrying no passengers, has much new equipment never before seen in the railroad world. The car weighs, complete, 80,000 pounds, and is mounted on two 4-wheel steel, tired trucks of light weight cast steel, with complete equipment of Timken roller bearings. Each of the 12-cylinder, 240 h.p. American-La France gasoline engines is direct connected to two main Westinghouse 600-volt generators and two auxiliary 50-volt generators. Each of the larger units drives two 300-volt electric motors for train power. The auxiliary generators drive the air-conditioning compressor, charge the battery, and carry the auxiliary load including the lights. The only wood used in the train is in the replaceable maple floor boards and some of the postal equipment in this car.

There will be no battles with sticking windows and no flying cinders in the second car. The windows are sealed shut and clean air, constantly circulated from ceiling ducts is refrigerated in summer and heated in winter.

The air-conditioning apparatus, all of which is located in the forward car, is of special light-weight design created by Westinghouse-Sturtevant. Refrigerated or heated air is conducted to the rear car through flexible ducts and, by thermostatic control, is kept at any desired temperature. In the forward car also is an oil fired heating boiler to provide heat in winter for both cars.

The rear car rides on sixteen pneumatic tires divided between two 8-wheeled trucks equipped with Timken roller bearings and is completely silent, there being no moving apparatus of any kind. The frames of these trucks are of stainless steel, "shot-welded" by the process originated by Budd on automobile bodies. The car is further insulated from vibration by a flexible coupler of Budd design, between the cars.

Safety features of the train comprise a quick acting double acting braking system, complete automatic lighting and signal equipment, non-shatterable glass, automatic power, electrical shut-off to avoid fire hazard, and automatic engine stops when the oil pressure fails.

The lengths to which the engineers have gone in the elimination of weight and the increase in strength of various features of this train are illustrated by the tanks, all of which are of stainless steel. The air reservoirs are of 3,000 cu. in. capacity, weigh only 17 lbs. against a normal weight of 68 lbs. Six stainless steel fuel tanks holding a total of 500 gals. of gasoline, or to be exact, 83 gals. per tank, weigh 45 lbs. each. The average steel tank of this capacity weighs around 300 lbs. None of the tanks on this train will ever need hammer testing because, being made of stainless steel, they will never rust.

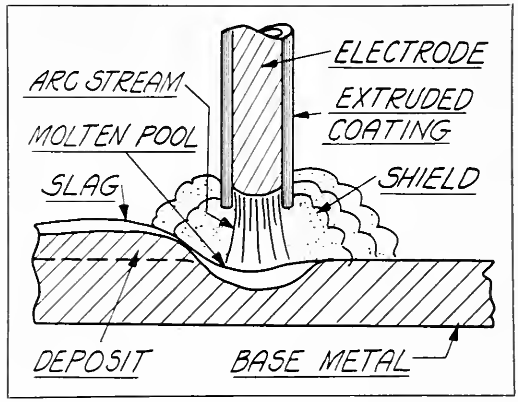
Motor Starting Gear

(From Electrical Review, November 3, 1933)

THE Midland Electric Manufacturing Co., Ltd., Barford Street, Birmingham, has extended the range of the "Auto-Momota" starting switches, by the introduction of a large size direct-on-line, push-button starter, suitable for motors up to 15 h.p., 200 to 500 V, and also by the introduction of a new automatic star-delta starter, push-button controlled, and a range of motor reversing controllers.

The star-delta comprises a main-line contactor and a special change-over contactor, which change the connection of motor windings from star to delta. The change-over contactor operates when the coil circuit is closed by a thermally operated relay about 20 seconds after the closing of the main-line contactor. The motor thus has ample time to gain speed before the change-over takes place. The thermal relay is automatically cut out of circuit in the delta or running position, and the length of time delay can be adjusted within reasonable limits. Thermal over-load trips, which are adjustable over a wide range, are provided on all three phases and no-volt protection is inherent. The starter is enclosed in an iron case with the push-button in a separate box, which may be used for local or remote control. The starter is entirely automatic, after the start button has been pressed, and is available for motors of 2 to 15 h.p. working on 200 to 250 V.

The reversing controller consists of two contactors mechanically interlocked and arranged with a push-button box for start, stop, and reverse. Thermal over-load trips are fitted on all phases, to give protection to the motor running in either direction. Two sizes are available, covering the requirements for motors of ½ to 15 h.p., 200 to 500 V. Isolating links are available for the whole range of M. E. M. control gear.



Shielded Arc Process of Welding.

Welding by the Shielded Arc Process

By H. M. Downing

(From Iron and Steel, November, 1933)

TYPICAL of the rapid progress in American engineering practice are the advancements made in the art of arc welding during the last few years. Due to improved welding technique, the speed of welding and the strength of the weld have greatly increased even as the cost and weaknesses due to impurities have become smaller.

This advancement is due to the comparatively recent adoption of what is known as the shielded arc process of welding. In this operation, the electrode is coated with an adhering substance to a thickness of ten to twelve percent the diameter of the rod itself. Its purpose is to protect the molten weld metal from the surrounding atmosphere. The presence of oxides and nitrides in a weld tend to impair its strength, ductility, and resistance to corrosion, and since our atmosphere is almost wholly composed of nitrogen and oxygen, this function of the shield is of obviously great importance.

As shown in the accompanying figure, the coating breaks down from the heat of the arc, and forms protective and chemically reducing gasses which oppose oxidation or nitridation of the weld metal. The coating, which is consumed at a slower rate than the metal, then forms a slag deposit over the weld, thus extending its protective function and, incidentally, slowing the rate of cooling of the weld. This latter is important in adding to the strength of the weld.

Superiority of the shielded arc process is plainly shown by its tensile strength of 65,000 to 75,000 pounds per square inch, compared to 40,000 or 50,000 pounds with a bare or even lightly coated electrode, and its ductility of twenty to thirty percent in two inches as compared to two to eight percent in the other case.

Important also in better welding results is proper regulation of the over run and the under run of the current used. Over run is the increase of current as the condition of welding is changed into that of short circuit. Excessive over run decreases welding speed, and increases splatter, porosity of the weld metal, and cost of weld-

ing. Under run is a decrease in current as the arc is lengthened, and tends, also, to decrease the speed of welding, to decrease shielding protection by failing to properly burn the coating, and to make slag pockets in the weld. New machines are designed to minimize both of these disadvantages.

Electrical Equipment for Theatres

(From Electrical Review, November 3, 1933)

THERE are some novel features in the reconditioned electrical installation at the Duke of York's Theatre. The most striking of these is the apparatus used in changing over from one to the other of the alternative 200 V supplies (i.e., general network and special theatre main). It consists of a rectangular steel bus-bar case running from end to end of the service intake room and divided into three sections to correspond with three separate fireproof compartments of the room. To the bus-bars in the end sections are connected the alternative incoming cables. A further set of bus-bars in the centre compartment projects into the end sections. The central bus-bars are connected through a 500A Statter circuit-breaker to an eight-way contactor switchboard. The connections up to that point are entirely of copper strip making a notably clean lay-out.

Heavy clip contacts are fitted to the ends of the bus-bars in the two end chambers to receive links for connecting either of the supply bus-bars to the installation bus-bars. Double insulated cover plates with slotted holes corresponding to the position of the clips are provided on the face of each end section. These cover plates are fitted one over the other so that the one on the underside is fixed to the chamber and the other is sliding in steel guides. The upper plates are coupled by a steel shaft, the lateral movement of which causes the two sets of holes in the plates of one end section, when in the extreme position in one direction, to coincide and admit the projecting blades of the connecting links. The two sets of holes in the other cover plates occupy different positions so that the apertures are closed.

When the connecting links are in position they lock the cover plates together and prevent the connecting rod from being moved, thus making it impossible to insert two sets of links at the same time. Auxiliary contacts are connected to the no-volt coil of the main circuit breakers. As these are energized only when the links are pressed right home, any attempt to withdraw the link, when carrying current, would disconnect the no-volt coil and trip the switch. This principle is applicable to any case in which it is not desirable to parallel two cables feeding an installation.

Distortion in Motion Pictures

By Clifton Tuttle

(International Projectionist, October, 1933)

LABORATORY tests and more potent tests of the box office are surprising proofs that the American cinema audience does not, for the most part, realize that it is seeing its favorites physically misrepresented. There is, in fact, considerable distortion of the screen figure due to projec-

tion on the screen from a point above it and the error in perspective due to off-center viewing.

In its study of the subject, the Society of Motion Picture Engineers has advised a projection angle of no more than seventeen degrees, an angle which produces an elongation of about five per cent in the image. This thinning process, if allowed to become greater, might radically alter styles throughout the country. It so happens, however, that most of the large theatres have a greater angle of projection than this. Besides its elongating effect, a large angle magnifies the bottom of the picture more than the top, thus making lines which should be vertical convergent towards the top.

Why don't movie-goers object? Actual tests with an audience which was unaware of the nature of the examination show that no one noticed elongation until it was ten percent in familiar inanimate objects, fifteen percent in human figures, and twenty percent in close-ups. The subject of convergent vertical lines is handled by the fact that the attention of the audience is not ordinarily focussed on vertical lines.

That viewing the screen from an angle is not objectionable until the angle reaches forty degrees was the concensus of opinion in the "laboratory" tests, but thirty degrees is the actual limit of comfortable vision. Distortion is noticeable before this mark is reached, but is not troublesome.

How can these inconveniences be corrected? Obviously the angle of vision can be kept down only by proper designing of the theatre. The front row of seats should be at least one and one-half times the width of the screen away from the screen, and no wider than this same dimension, and the rest of the house built accordingly. A partial solution is also effected by a curved screen surface.

Projection angle can easily be corrected for by tilting the screen, but this operation apparently involves mechanical difficulties, as it is seldom used.

The whole question is still an interesting one for study, and it will take some new inventive ability to find a solution.

ENGINEERING PROGRESS

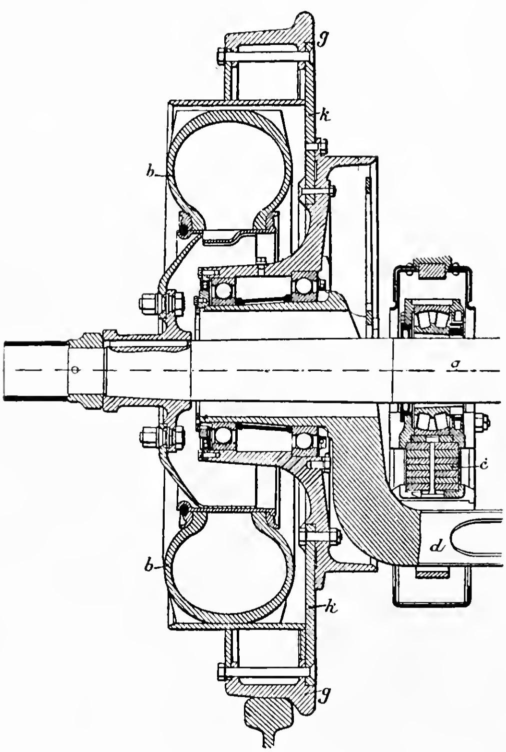
NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

Pneumatic Tires Within Wheels

(From "Automotive Industries)

THE newest type of European railcar has wheels with pneumatic tires that roll on the inside of drums of slightly larger diameter, attached to flanged car-wheels. The illustration represents the axle and wheel construction for the rail-car.

There are two axles, one of which carries the flanged wheel and the other the pneumatic tired wheel. The axle carrying the rubber-tired wheel is solid and extends through a large-diameter hollow spindle of the cranked axle carrying the flanged wheel on ball bearings. The leaf springs for the truck are hung from the revolving axle carrying the rubber tires through roller-bearings of the double-thrust and radial type. Any shocks to the flanged wheel such as those due to rail joints are cushioned by the pneumatic tire. It is stated that the load per axle can be as high as 7 tons, but it is planned to bring out a similar design for greater loads. Test runs have been made with a railcar having axles of this design, i.e., for 35 passengers and two operators' stands. With a 80 h.p. engine this car ready for service, weighed 17,600 pounds, and in the test it attained a speed of 62 m.p.h.



View of New Type Wheel.

Photo-Electric Water Hardness Meter

THE development of a new device for automatically checking the hardness of water has been recently announced. Through the use of a photo-electric cell the device periodically tests the hardness of water and sounds an alarm when the hardness reaches a predetermined limit.

The method of operating this instru-

ment is a very simple one. A sample of water from the soft water supply is led into a glass cylinder at intervals and to this water a small quantity of chemical is added. The slightest hardness causes a change in color and turbidity so that the current output of the photo-cell, which is illuminated by a beam of light passing through the glass cylinder, is proportional to the hardness. The hardness can thus be read on a meter scale. Furthermore, when it surpasses the limit for which the instrument is set, an alarm is caused to ring.

For use with water which varies appreciably in color or turbidity, a second type of meter has been devised. In this instrument, two photo-cells and two test cylinders are used. Simultaneous samples enter the cylinders and the chemical is added to one. The electrical circuit of the cells measures the difference between the light-absorbing characteristics of the two samples and the result is thus independent of the original turbidity or color of the water.

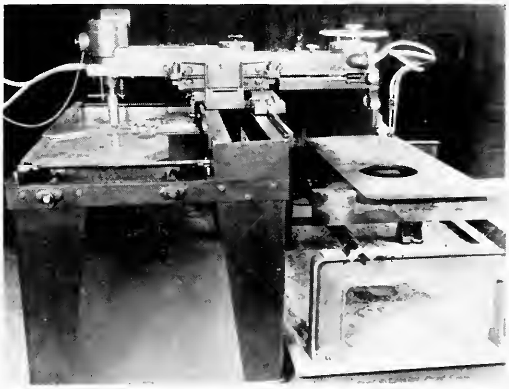
A New Air Compressor

A NEW type of air compressor has recently been perfected. The new machine's built-in motor is so constructed that the motor rotor is carried on the compressor shaft and the motor frame is bolted directly to the compressor crankshaft. By this construction a coupling and several motor bearings have been eliminated. The rigid base underneath the entire unit makes for a compact machine. The compressor is a two cylinder two-stage machine. The intercooler and the cylinders are air cooled. The machine's efficiency is about the same as that of the conventional water-cooled compressor of like capacity. The compressor will increase the use of compressed air in places where cooling water is unavailable.

The Oxweld Pantosec Introduced

AS AN addition to the Oxweld line of welding and cutting apparatus, The Linde Air Products Company has introduced a new stationary cutting machine of amazing versatility, known as the Pantosec. Being a precision shape-cutting instrument, it is especially suitable for cutting dies, cams, and other parts that must be smoothly and accurately cut. With a cutting range of 44-in. longitudinally and 20-in. laterally, it does straight-line cutting, angle cutting, beveling, circle-cutting and intricate shape-cutting. It requires a floor space of only 72 x 83 in.

The Pantosec can be operated with a minimum of attention from either the templet end or the blowpipe end, as a hand-guided or as a machine-guided in-



Oxweld Pantosec.

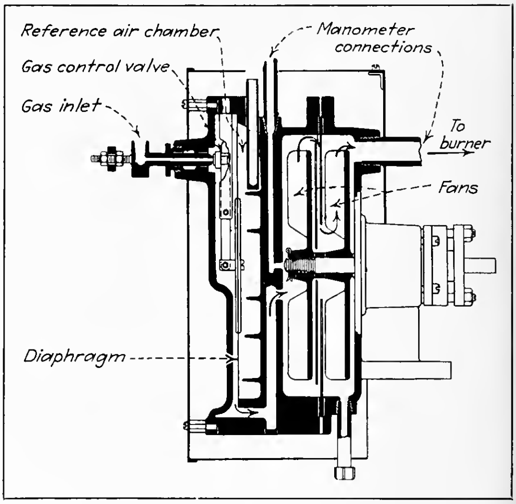
strument. Angles can be cut without templets, since the cutting head can be locked for travel in any direction. Bevel-cutting is simplified; the provisions for adjusting the machine to the work make it possible to line up the blowpipe without shifting the work; and the dividing head enables the operator to set stops on work that is to be cut in several directions.

An extension so mounted as to be always steady and secure, makes it unnecessary for the operator to return to the back to start the profile cutting after the entry cut has been made.

The machine consists of a carriage mounted on three-point supports. The piping for the gases is all enclosed in the carriage, and all drives are protected by dirt-proof casings. The motor may be specified when ordering to run on either 110 or 220-volt current. All wiring is concealed, and the switches and controls are clearly labeled and easily accessible.

Compensating Gravity Meter

THE successful development of a new recording instrument for continuously measuring the specific gravity of a gas has been recently announced. This device is described as being the only instrument which will automatically correct for variations in both temperature and pressure of the gas and record the corrected values. The principle of this instrument is illustrated in the accompanying sketch. The apparatus consists of three chambers inclosed within an asbestos-lined jacket, so that the temperature of all three chambers is the same. The first chamber,



Compensating Gravity Meter.

at the extreme left, serves for the admission and control of the gas. The second chamber (in the center), is sealed, containing a definite quantity of air under a pressure of 30 inches of mercury at a temperature of 60° F. The third chamber contains a pair of fans rotated by a constant-speed motor for the measurement of the density of the gas.

In operation, the gas enters through a small reducing valve where its pressure is adjusted by means of the diaphragm and valve to be exactly equal to that of the air in the sealed chamber at the temperature of operation. Gas flows into the center of the two-stage blower from which it is expelled to a burner. The pressure differential between the inlet and outlet of the blower constitutes an exact measure of the density of the gas (and of the specific gravity since the temperature and pressure equal that of the standard). It is this differential which is recorded by the instrument.

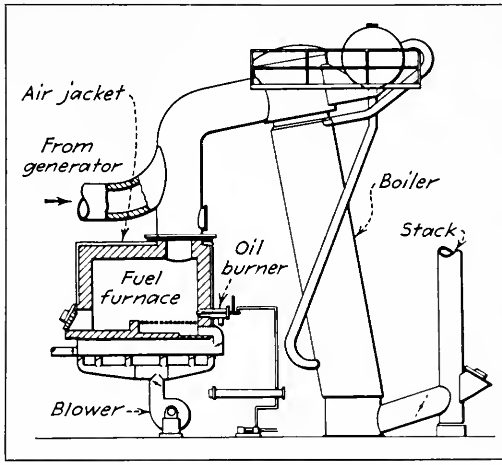
A Mercury Vapor Detector

A NEW mercury vapor detector has been developed which can detect one part of mercury in 100,000,000 parts of atmosphere. The detector is more rapid in operation and is capable of giving warning in one-third less time than formerly required.

The flue gases are continuously drawn in from the boiler stack by this device. After the gases are treated to remove impurities, they pass through a beam of ultra-violet rays coming from a mercury light source. The beam is directed toward a quartz-sodium phototube which detects any mercury vapor which may be present. To the new device a mercury detector of the type previously used is attached to act as a check. By means of this device, the mercury vapor losses can be decreased and the economy of operating the boiler can be noticeably increased.

Waste Heat Boiler

A NEW form of combination waste heat and fuel fired boiler has been recently developed. This boiler is designed for use in water gas plants, and may be operated either by blast gases alone or by the blast gases in the automatic cycle with a fuel-fired combustion unit. Air for the latter, which is intended to burn surplus tar or low-grade oil, is preheated by passage through an air jacket surrounding the combustion space. Among the advantages of the new equipment are the small floor space required, the lack of additional plant labor, and its automatic operation. It is



View of Boiler.

said that this type of boiler has a very high efficiency and by its use the steam costs may be greatly lowered.

Features of New Tire Valve Assembly

SEVERAL new features have been added to the standard type of tire valve by incorporating the valve cap and the dust cap into one unit, the floating valve cap. The floating valve cap, when attached to the valve stem, seals it and permits the dust cap shell to slide up or down. This gives the length necessary for ease in mounting the tire on the rim. The complete unit may be inserted through the valve hole, and the tire mounted without the removal of any part.

When the tire goes flat, the entire valve pulls back into the rim without strain on the valve. Usually a flat tire on a running wheel results in tearing the tube at the valve stem. The pull back feature eliminates the possibility of this sort of injury, which often cannot be repaired economically.

Motor Speed Control

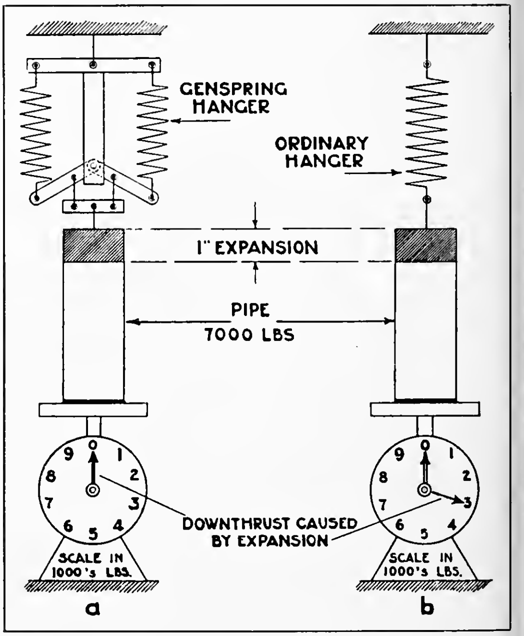
EFFICIENT operation at variable speeds of a synchronous motor, by means of a new type of vacuum tube control has been recently demonstrated. The equipment used in the demonstration consists of a 400-h.p. motor and eighteen Thyratron tubes. Power is fed into the bank of tubes directly from a 4,000 volt line. The tubes convert this power into different frequencies before it is delivered to the motor. This varying frequency in the current results in varying speeds of the motor. Thus in the changing of the frequency of the current, the tube performs the function of a commutator. A secondary but not unimportant feature is the grid control which makes it possible to start with full torque from stand-still and to operate the motor at any desired speed without wasting power in resistance.

Much more engineering work is necessary before this apparatus can be used commercially. However, this development is of importance in that it points the way to a new era in the electrical industry, in which many important functions and power transformations will be performed by vacuum tubes.

Pipe Hanger Prevents Non-Axial Forces

ONE problem of pipe installation is to provide full support for horizontal piping that has considerable vertical movement due to the expansion of riders as the pipe temperature changes. A new type of pipe-hanger is designed to give constant support to the pipe during vertical movements of as much as two inches and at the same time will not permit non-axial stresses due to expansion to develop in the pipe joints or in other parts of the line. However, free horizontal movement of the line is allowed.

The constant support feature is achieved by supporting the weight of the pipe not directly on the springs but through levers which compensate for the changes in the supporting effort of the springs as they are deflected by vertical movements of the pipe line. In this way the levers balance the supporting effort with the load in every position, and consequently no part of the load is at any time unsupported. This hanger weighs 160 pounds and will support all loads from 500 to 7,000 pounds and permits of a vertical rise of two inches.



Sketch Showing Operation of New Type Pipe Hanger.

Use of Anthracite Coal in Water Filtration

ANTHRACITE coal has been in use in filters for a number of years, but only recently have tests been made by several eastern engineers, comparing its use to that of sand. From these investigations it is found that anthracite has some decidedly better qualities than sand, which have caused it to be termed the "ideal filtering medium".

One advantage discovered is that, due to the low specific gravity of anthracite (about one-half that of sand), a lower velocity and smaller quantity of wash water can be used, with a resulting economy in wash water equipment. To expand the anthracite filter bed 5%, only about one-half the wash water velocity is needed as for expanding a sand bed the same amount. Due to the angular shape of the particles, the coal exposes more surface to the floc than do the rounded sand particles. The floc penetrates deeper, preventing clogging or incrustation near the top, and eliminating the slime or "schmutzdecke" of sand filters.

The size of particles is uniformly distributed through the depth of the filter bed, and as the coal bed being more porous than the sand bed, longer filter runs are possible. The cost of filling a filter bed with anthracite coal is about the same as for sand. The coal has very good qualities in removing colors, odors, turbidity, excess chlorine, and bacteria.

Several large cities are using this material in their water treatment, and it seems that the day of the "schmutzdecke" is passing.

"Low bridge", shouted the bus driver. "Everybody keep their seat and face to the front."

1st Cannibal: "Gosh, I forgot the roast; the missionary is burning."

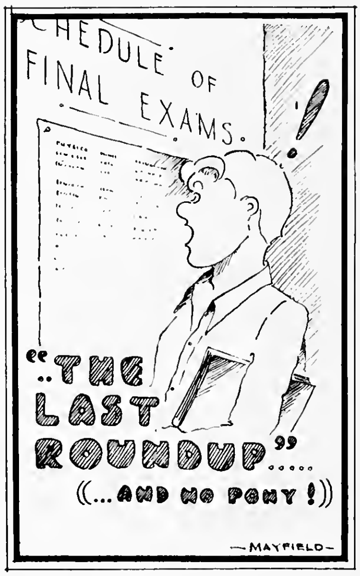
2nd Ditto: "Holy smoke!"

A soldier went to see his colonel and asked for leave to go home to help his wife with spring house cleaning. "I do not like to refuse you," said the colonel, "but I've just received a letter from your wife saying that you are no use around the house."

The soldier saluted and turned to go. At the door he stopped:

"Colonel, there are two persons in this regiment who handle the truth loosely, and I am one of them. I am not married."

—*Neb. Awgwan.*



Coroner: "And what were your husband's last words, madam?"

Widow: "He said, 'I don't see how they make any profit on this stuff at a dollar a quart'."

Father (sending his son to Paris): "Don't do anything that I'll be sorry for."

Early to bed and early to rise keeps your roommate from wearing your ties.

It is generally known that a B. S. in Engineering and ten cents will buy a cup of coffee.

News Item—An alligator can go six months without eating. Just the pet for an architect.

Customer: "Where's the menu?"

Waitress: "Down the aisle and the first door to the right."

We would like to remind our lecturers that the longer the spoke the longer the tire.

Mary, Mary, quite contrary,
How does your garden grow.
But Mary was a tough little girl, and said
"Who the —L wants to know?"

Stranger: "Don't fast trains ever stop here?"

Hecker: "Certainly. Had a wreck here once."

G-E *Campus News*

[illegible]

[illegible] G-E [illegible] Glyptal [illegible] made [illegible] molecules [illegible] found [illegible] varied [illegible] the polyesters [illegible] be interested [illegible] pounds [illegible] brush band [illegible] mobile brushes [illegible]

These [illegible] Glyptal [illegible] it [illegible] its tenacity [illegible] other insulation [illegible]

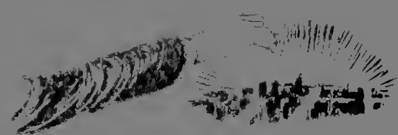
[illegible]

It's just the [illegible] veterinarians [illegible] this new portable [illegible] long ago by [illegible] '16, now president [illegible] peration.

The set [illegible] operates [illegible] industrial [illegible]

[illegible] radiographs of locked trunks, suspicious packages, and the like. It is particularly adapted to making x-rays of animals and for use in cases where the machine must be moved to the patient. [illegible] can operate [illegible]

[illegible] practicable reach [illegible] The first set built was [illegible] Chicago to Belmont Park [illegible] to inspect the right [illegible] horses of the [illegible] turf which was on the point of being [illegible] for a puzzling lameness. [illegible] operation of the [illegible] the horse was not in the least nervous. [illegible] Equipoise, [illegible] along."



[illegible] PERFECT

[illegible] pure" may be [illegible] the matter of [illegible] lights—well, lend [illegible]

[illegible] lighting in [illegible] Mass. In the last [illegible] 32 failures (from [illegible]) in 350,928 [illegible] within .0091 [illegible]

[illegible] wires and transformers [illegible] duplication [illegible] In Springfield [illegible] transmitted for [illegible] controllers, turns [illegible] seconds it turns them [illegible] of 400 cycles is available [illegible] water heaters and [illegible] This is the only G-E installation [illegible] distinction, we [illegible]

[illegible] '12, F. M. [illegible] and J. L. [illegible] '24, were [illegible]

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GENERAL ELECTRIC

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ILLINOIS

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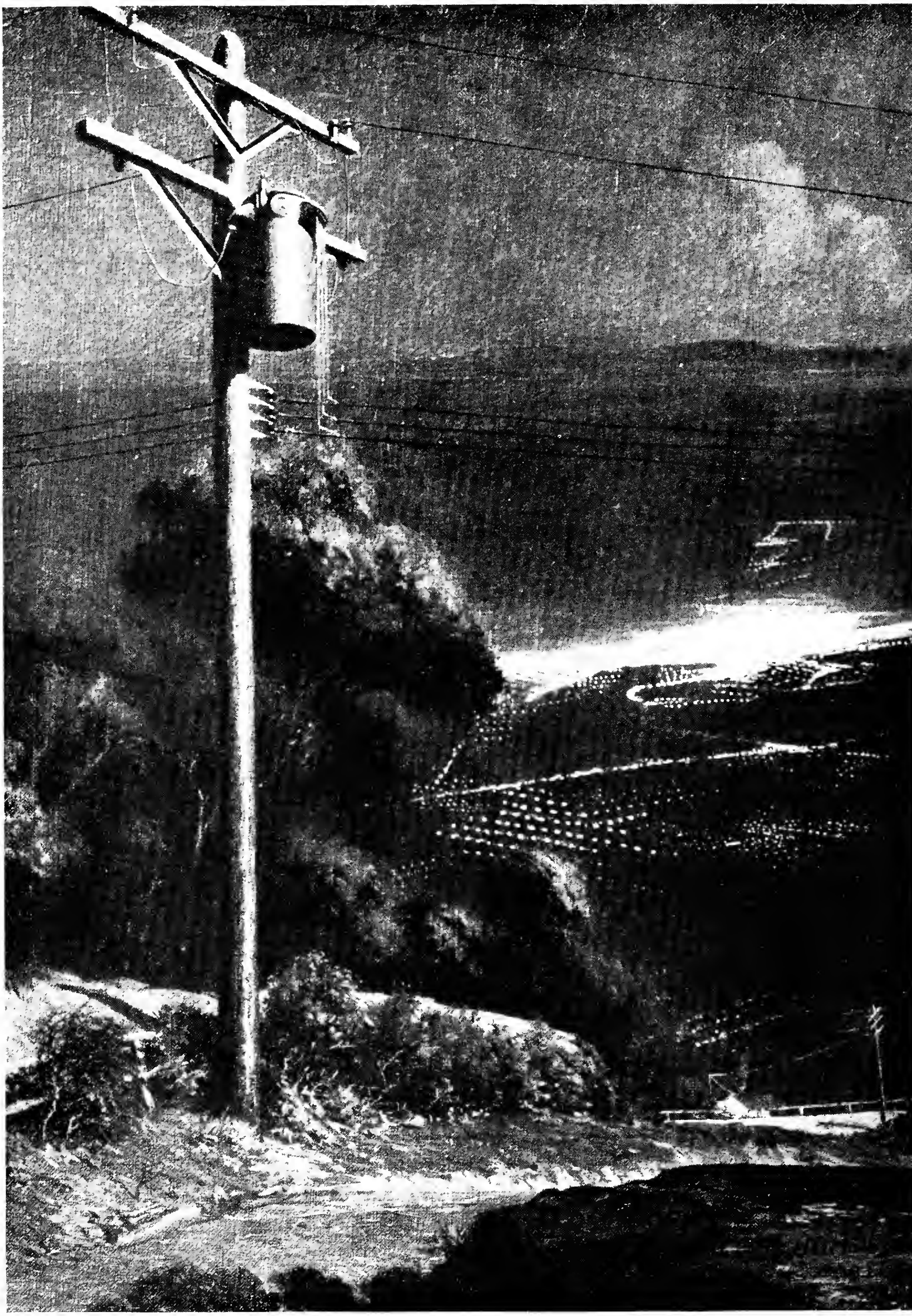

Sentinel of the Night

Courtesy General Electric Co.

THE

ARMOUR ENGINEER

MARCH, 1934

Co-ordinated Production of Industrial Steam and Utility Power

By A. R. SMITH

THE utility and the industry have certain fundamental objectives in common, namely: a larger market, a better product, and the lowest investment. The utility wants to produce and sell all the power in the district—which has several well understood advantages. The industry requires steam which is generally not purchasable and, therefore, has to carry the investment of a steam plant, which frequently, with little more investment, may produce electric power at an attractive figure.

Many attempts have been made without success to close this breach and co-ordinate the efforts of industry and utility, and the reason usually has been that both parties want to show a good profit and there is not always enough apparent margin available. There are, however, many latent advantages which may be more attractive than the percentage profit.

Industry should consider that the business cycle, the possible changes in manufacturing methods and the demand for its product may have a decided and unforsee-

This article was presented at the sectional meeting of the World Power Conference at Stockholm, Sweden, by A. R. Smith, Managing Engineer of the Turbine Department of the General Electric Company.

able influence on the load factor of a contemplated power plant, and, therefore, such an investment should show a high gross return.

Industry should have the lowest investment for things which are purchasable, making it possible to extend manufacturing operations rapidly, or shrink in depression periods with less disastrous effects, and thus ride in harmony with the rapid change in trades, demands, styles, and other controllable factors.

Utility should consider that high thermal efficiencies, if not too dear, are very desirable at times of high fuel costs or fuel shortages, or in the event of social or national strife; that steam plants of reasonable size strategically located in industrial centers reduce transmission costs and serve in times of stress when systems are in trouble or seasons dry; that steam boilers used for heating industry in winter may be used as power boilers in summer, and that an operating crew in an industrial center may serve an idle crew in some standby plant.

Of course, utility cannot engage in the manufacture and distribution of steam unless the clients are permanently established, or unless there is a group of industries which will assure a continued demand year after year, due to diversity. The size of the industry or group is also important, as it is obvious that a utility cannot provide or operate many very small plants economically. On the other hand, industries may migrate to localities where such steam service is available.

Insufficient attention has been given to the co-ordination of industry and utility, transportation, civic conditions, social life, and, in fact, industry and industry. Serious and enlightened planning of industrial localities on the part of city governments should be beneficial from the standpoint of lower taxation, better transportation facilities, minimum smoke offense, least pollution of rivers, and be an inducement for utilities to set up facilities to supply steam to grouped industry.

One of the difficulties in analyzing this situation is the different characteristics of the electrical load and the steam demands. The electrical load has a predominating daily characteristic, while the steam demand has a predominating seasonal characteristic. It has been difficult to illustrate without resorting to three dimensional graphs the true productibility or availability of by-product power. The other difficulty has been the limited amount of electric power which could be developed from the usual low steam pressures available in the past. It is not the intention to show how these studies may be made for all applications, but rather to show how such studies were made for the Schnectady factory of the General Electric Company.

There were required immediately 400,000 lb. per hour of steam at 200 lb. per sq. in. gauge pressure, 525° F. temperature and 25,000 kw. of 60 cycle power. Ultimately there would be required 900,000 lb. per hour of steam at 200 lb. per sq. in. gauge pressure, 525° F. and 55,000 kw. of 60 cycle power. Studies were prepared to see if this 400,000 lb. per hour of steam should be produced at 200 lb. per sq. in. gauge pressure with no by-product power recovery, or if it should be produced at

some higher pressure, or by means of interposing the mercury cycle.

On account of the importance of maintaining the feed water for high pressure plants at its maximum purity, it was considered advisable for systems operating above 400 lbs. per sq. in. gauge pressure to reduce the steam going out to the factory in evaporators because of the hazard of contamination in the factory. In such a case the initial superheat might be selected to allow a negligible amount of superheat to enter the evaporators, but the possibility of straight condensing operation suggested adherence to the prevailing standard superheat temperatures and the results were found to be sufficiently alike to justify consideration of the latter only.

The following tabulation shows how much electric power could be produced from a factory steam demand of 400,000 lb. per hour at 200 lb. per sq. in. gauge pressure with a turbine generator efficiency of 80 per cent.

Initial Steam Conditions	Entering Evaporator
200 lb.—525°F.	No Evaporator
400 lb.—750°F.	No Evaporator
600 lb.—750°F.	400 lb.—670°F.
1200 lb.—750°F.	400 lb.—518°F.
2400 lb.—1000°F.	400 lb.—618°F.
125 lb. Mercury	28 in. Hg. Vac. to 400 lb. H_2O

Exhaust Steam Conditions	Kilowatts
200 lb.—525°F.	No Kilowatts
200 lb.—625°F.	5970
200 lb.—Saturated	5150
200 lb.—Saturated	13750
200 lb.—Saturated	24050
200 lb.—625°F.	42200

It was obvious that the introduction of evaporators for the 600 lb. proposition made that cycle less attractive than the 400 lb. proposition, and that the mercury power production possibilities were far in advance of the others. A comparison of investment costs of the steam cycle was then prepared with the following results:

Initial Steam Conditions	Electric Power	Investment Cost
200 lb.—525°F.	No Power	$1,600,000
400 lb.—750°F.	6,000 KW	2,500,000
1200 lb.—750°F.	14,000 KW	3,100,000
2400 lb.—1000°F.	24,000 KW	3,700,000

The unit investment cost chargeable to power is the difference between any of the latter three and the 200 lb. proposition, which produced no power.

Initial Steam Conditions	Unit Investment Per KW	Investment Chargeable to Power
400 lb.—750°F.	$150.00	$ 900,000
1200 lb.—750°F.	107.00	1,500,000
2400 lb.—1000°F.	87.50	2,100,000

The mercury cost was omitted from the comparison because the amount of power which could be developed meant constructing two mercury units, which was considered inadvisable at that time. A comprehensive analysis was made of the application of the mercury cycle to the present and future conditions, and the relative cost computed on various assump-

tions. First, that the extra steam obtained from the mercury process over and above the 400,000 lb. per hour cost the same as the original 400,000 lb., the unit investment per kw. in mercury power equipment was considerably less than for any of the steam power propositions; Second, that the unit investment in mercury power equipment was the same as for the 2400 lb. proposition, the least of the figures for steam. Then the cost for extra steam was considerably less than for the original 400,000 lbs. of steam. The precise accounting is a matter for judgment. It will suffice here to say that by either possibility the combination represented an economy in the matter of investment that was attractive.

As is well known, the heat chargeable to power, when the heat of the exhaust steam is credited to process, is only the heat in a kw.-hr. plus the external turbine generator loss divided by the efficiency of the steam generator, thus making the heat of the fuel chargeable to electric power in the order of 4,500 B.t.u. per kw.-hr. The real secret of securing the greatest economy from by-product power production is to develop the largest amount of such high thermal efficiency energy which can be produced with a limited amount of process or heating steam available.

During the preparation of the designs modifications had to be introduced which increased the available steam producing capacity, so that the equipment now consists of

One steam boiler 400 lb. per sq. in. gauge pressure, 750° F. capable of producing 325,000 lb. per hour.

One mercury boiler and turbine capable of producing 20,000 Kw. and 325,000 lb. of steam per hour.

One non-condensing turbine generator for operating from 400 lb. per sq. in. gauge pressure to 200 lb. per sq. in. gauge pressure and capable of producing 6,000 Kw.

The plant, therefore, has a capacity of 26,000 Kw. and 65,000 lb. per hour of steam.

Attention has already been called to the necessity of using pure feed water for high pressure steam, and that reasonably good water is generally satisfactory for 400 lb. per sq. in. gauge pressure. The exhaust of the mercury at 27.5 in. Hg. of vacuum (30 in. Hg. barometer) produces steam at 400 lb. per sq. in. gauge pressure, which can be made from a poorer quality of water than a fuel fired boiler because the temperature differential between the inside and the outside of the heating surface is only from 20 to 30° F., and because all of the heating surface works uniformly. Any scale deposit simply reduces the effectiveness of the heating surface, but the heating surface can never oxidize or burn out as there are no high temperatures present.

The initial investment in mercury is dependent on the design of the equipment and the cost of the mercury. The units referred to in this paper require 275,000 lb. which, figured on the basis of a 50,000 kw. mercury vapor steam cycle, amounts to 5.5 lb. per kw. The operating loss is negligible because the only escape, except through accident, is the air pump discharge from the condensers, and the after-condenser cooling water temperature of under 100° F. reduces the vapor tension which

has left the condenser in excess of 400° F., making this loss practically nil. Loss through accident is reduced to a minimum by the provision of water sprays in the flues, while any loss as liquid will be caught in the combustion chamber.

There has been no evidence of any sickness or disability attributable to mercury poisoning throughout the fifteen years of development and the five years of commercial operating experience. A very sensitive instrument has been developed which will detect the slightest presence of mercury vapor in the flue gases. It may be used to announce by means of alarm or even shut the unit down in the event of trouble.

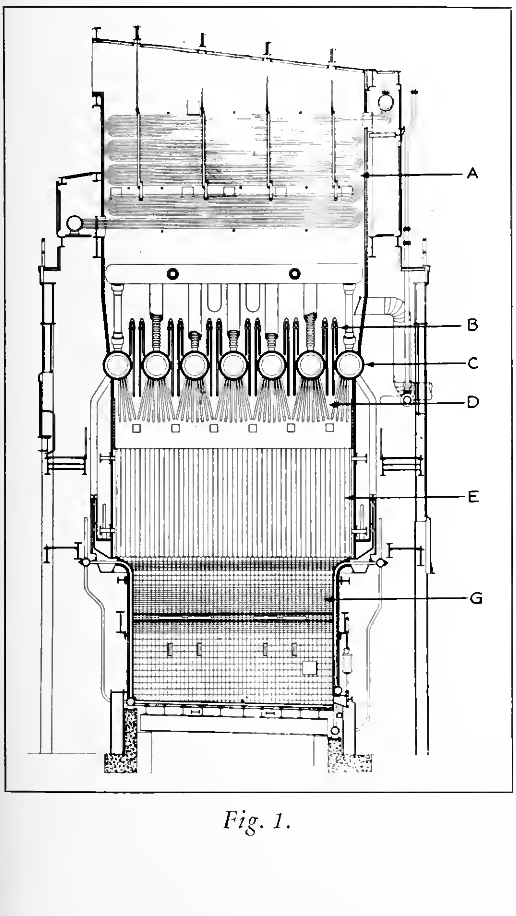

Fig. 1.

In the accompanying illustration, Figure 1, the mercury side walls are shown extending from below the porcupine tubes for a distance of 15 feet. They consist of three steel tubes embedded in copper in a steel armor channel which is calorized. The drums with their porcupine tubes have had sufficient publicity in connection with the Hartford installation to make any description here unnecessary. Between the drums are located the mercury liquid heaters which should be called economizers—in fact they are what are now termed "steaming economizers".

The furnace bottom and the sides for a height of 15 feet are water cooled with block covered tubes, which is the usual Babcock & Wilcox construction for slag tap furnaces. The 400 lb. steam produced in the mercury condensers, amounting to 240,000 lb. per hour, and the 400 lb. steam produced in the lower section of the furnace amounting to 85,000 lb. per hour, is superheated to 750° F. in a usual convection type superheater illustrated at the top of the picture.

The mercury turbine is a double flow 5-stage 20,000 kw. unit designed for 125 lb. mercury pressure at the throttle, and exhausting at 27.5 in. Hg. vacuum referred to a 30 in. barometer.

Figure 2 shows an elevation of the Schenectady Works installation. Unlike the Hartford, Conn., and the Kearny, N. J., installations, the Schenectady mercury turbine is at the usual turbine floor level, and the mercury is delivered back to the boiler drums by means of centrifugal pumps. It is interesting to note that the pumping horsepower to return the mercury liquid back to

the boiler against 125 lb. per sq. in. guage pressure is only about one-fifth of the horsepower to return the condensate back to a 1,200 lb. per sq. in. gauge pressure steam boiler of equal capacity. In this case the pump is a single stage overhung impeller of 11 in. diameter running at 1,800 revolutions per minute.

The introduction of large, reliable boiler units, the completely enclosed turbine generator, and the tendency toward unit grouping of apparatus has suggested the introduction of the "outdoor" steam plant. It may be termed a power or steam generating machine composed of apparatus built by different companies and assembled as a machine with as little housing as appeared to the designer to be essential. The building structure is secondary to the apparatus and is largely of metal so as to resist abuse and to make extensions possible with negligible waste by simply moving the extendable end almost bodily.

Power or heating plants for industry generally grow over a long period, during which time styles and sizes of apparatus change so materially as to make the original building plan quite unsuitable for contemplated new equipment. Furthermore, buildings are especially designed to suit the original equipment and it seems unwise to construct a special building good for a life of 75 years to house apparatus which may have to be replaced in 25 years.

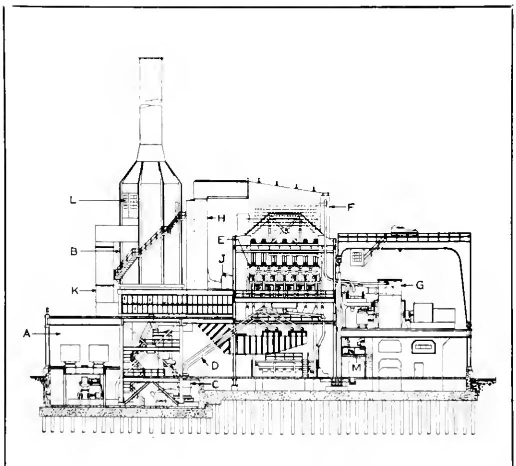

Fig. 2.

To attempt to show the saving in investment cost would be hopeless because such comparative estimates are based on many assumptions subject to the prejudice of the designer, and would lead to controversy.

Indoor steam plants have many inherent faults, and while correct designs with sometimes accompanying increase in cost may eliminate them one can hardly point out a single station which is completely free of them.

There are, for example, the possible condensation in the turbine room; the disastrous effect of an oil fire; the explosion hazard from coal dust; the panic of operators in the event of a ruptured steam main; the freezing of water lines due to cold air flowing in through windows; drafts resulting from taking combustion air from inside the building; the gaseous air in the boiler room due to the difficulty of proper ventilation; the accumulated dust throughout the structure which must be removed to avoid spontaneous combustion; the many dark and inaccessible places on the various floors or galleries where operators are stationed and not always effectively employed. Also, there are many hot, disagreeable and awkward places where repairs to apparatus must be made which may be as bad the year around as

the objectionable wind, rain, cold and snow conditions which may be encountered in an outdoor station during a portion of the year. It is not the author's intention to belittle the difficulties which may prevail when making repairs in bad weather, but rather to anticipate exaggeration on the part of the critics of outdoor steam plants.

No claim is made that this outdoor plant avoids all such faults, and as a matter of fact the apparatus which requires most maintenance, attention and operating supervision has been suitably protected against the weather. In other words, it is a compromise because it was the first attempt; because the mercury boiler is a relatively new piece of apparatus, and because the winters in Schenectady are long and severe.

Certainly, there are many things which do not need housing, such as coal bunkers, blowers, fans, air preheaters, superheaters, feed water heaters, deaerators, evaporators and other static machines. Large apparatus such as boilers, where a good share of the repairs are made from within, can just as well have their exterior casing made weather-proof.

The mercury turbine and condensers operate at 475° F. with the center portion of the turbine at 950° F. The insulation must be exceptionally thick and the slight difference between the average inside and outside temperature is no great factor. Furthermore, these units are hermitically sealed by welding with the exception of the two shaft packings.

The purpose of housing the coal unloading facilities was to permit the thawing out of the coal cars in winter and confine the coal dust on account of the close proximity of the steam plant to the factory.

One possible operating contract would be to sell electric power at prevailing scheduled rates and to sell steam at established rates per thousand pounds according to the pressure, which rates would be determined according to how much electric energy was produced from it as compared with what could have been produced by straight condensing operation. For example, 400 lb. steam, if no power were produced therefrom, would have a unit selling price of (A) cents per 1,000 lb. If it were produced by means of the mercury cycle there would be a certain credit allowed to the industrial. If steam of only 70 lb. pressure is required by the industrial, it would be a still lower grade by-product and the credit would be more. Five pound steam for heating purposes made by means of the mercury cycle would have as low a fuel

A - INDUCED DRAFT FAN ROOM
B - FLUE
C - AIR PREHEATER
D - STEAM BOILER
E - STEAM SUPERHEATER FOR MERCURY BOILER
F - COAL BUNKER
G - FORCED DRAFT BLOWERS

View of Schenectady Plant.

consumption for power as 400 lb. steam expanded to high vacuum and the credit to the industrial would be maximum.

The plan of operation in this case is on an entirely different basis. The industrial provided the capital and constructed the plant and the utility leases the plant on the basis of the fixed charges on the actual investment as a yearly rental.

The utility allows that a plant having a capacity of 26,000 kw. has a certain value per kilowatt of capacity to them, and the fixed charges on such investment is credited to the industrial. This amount is less than the rental, because the actual cost of the plant provided for not only the production of 26,000 kw., but also 650,000 lb. of steam.

The utility also allows a credit for each kw. hr. produced by the plant, all of which goes into their system. This credit is based on the prevailing costs of producing power with modern plants supplying their system, taking into account the fact that the utility must always accept the power produced according to the steam demand regardless of the hour of the day or the season of the year.

The utility sells all the power that the industrial demands at scheduled rates regardless of this particular agreement, and the excess cost covering the rental, the operation and maintenance and the fuel over and above the two credits allowed the industrial, is charged to the industrial as their cost of steam.

Observations on Viscous Flow

By PROF. J. F. MANGOLD

IN this article an attempt will be made to present a few features of the problems involving viscosity together with some solutions of actual problems, from which the effects due to viscosity may be more readily visualized. In the past there has been a considerable discussion of problems, but it has remained for quite recent investigators to digest and coordinate the scattered material and render it available for the solution of numerical problems.

When water or any other liquid flows through a straight pipe, the liquid in contact with the pipe either does not move or else moves very slowly, while neighboring layers slide over each other. Actual measurements show that the velocity is a maximum at the center of the pipe, and gradually decreases to a minimum at the surface of contact. There is, in effect, a relative displacement of hollow concentric cylinders of liquid similar to the movement which takes place when a telescope is extended. There is an internal friction caused when one layer of liquid is displaced relative to another. This internal friction is called viscosity. In the case of liquids like thick syrup, this internal friction is large. If it were not for the initial drag or friction between the pipe and the adjacent liquid, the entire liquid cylinder would move with the same velocity throughout.

Newton was among the first to formulate a theory of viscosity, and to derive an expression for the force required to overcome viscous resistance. He observed that if a portion of a liquid is displaced relative to another, the motion will gradually cease unless continued by the application of extended force. Further, if a portion of a liquid is kept moving, the motion will be gradually communicated to the rest of the liquid. Newton ascribed such effects to an action between the particles resembling friction between solid bodies.

Newton's conception of the action of viscosity amounts to the following: If two planes, having an area of contact A, move in a liquid with constant velocities, v and v_1, the force required to maintain the constant difference of velocities will be proportional to the area, also proportional to

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the difference of velocities, and inversely proportional to the distance between the planes. Introducing a constant of proportionality,

$$F = K A \left(\frac{V - V_1}{Z - Z_1} \right)$$

In the equation, z is measured perpendicular to the planes. Since the velocity in the liquid changes continually in passing from one plane to another, the differences may be replaced by differentials, and

$$F = K A \frac{dv}{dz}$$

Experience has shown that K is a characteristic constant for each liquid, and that at ordinary pressures it decreases as the temperature increases, but seems to be independent of $\frac{dv}{dz}$. K is called the co-efficient of viscosity. Its physical significance will become clearer if the factors in the right hand side of the equation above are each chosen equal to unity. The co-efficient of viscosity may then be designated as the force required per unit area to maintain a unit gradient of velocity or, in other words, it is the force required to maintain a unit difference of velocity between two planes in the liquid at a unit distance apart. This co-efficient may be expressed in dynes, centimeters, and seconds. The value equal to 1.00 is called a Poise, and the hundredth part a centipoise. This co-efficient for water at 20° C. is very nearly a centipoise, and is generally assumed at that value in computations. In English units the co-efficient is expressed in poundals, feet and seconds. Its value in these units at 20° C. or 68° F. is .000672. In the discussion above, it is assumed that the liquid has been displaced in layers or in concentric cylinders. Flow under such conditions is called laminar or stream line flow.

The early hydraulics of fluids as developed by Bernouilli, Euler, and other investigators dealt exclusively with ideal fluids in which no internal friction was considered. The experiments conducted always showed very considerable discrepancies between theory and practice. Bernouilli attributed these discrepancies to the adhesion of water to the sides of the pipe. In these investigations the flow was turbulent rather than streamline. The common expression for flow in pipes was derived and, where the resistance neutralizes practically all of the energy, appears in the form

$$h = \frac{f\ l\ v^2}{d\ 2\ g}$$

or, since pressure = w × head,

$$p = \frac{f\ w\ l\ v^2}{d\ 2\ g},$$

where w is the density. In this equation the factor "f" represents a resistance factor which was thought to vary with the roughness of the interior of the pipe, with the velocity, and inversely with the diameter of the pipe.

More recent investigations have shown that the friction factor for both viscous as well as turbulent flow is actually a function of the pipe diameter, velocity of flow, density of the liquid, and the viscosity of the liquid. Stated in symbols, f varies as $\frac{d v w}{k}$, where d represents the inside diameter of pipe in feet, v is the velocity in feet per second, w is the weight per cubic foot, and k is the absolute viscosity of the liquid.

The relation of these terms is dimensionless and leaves only an abstract number. Thus

$$\frac{d\,v\,w}{k} = \frac{(\text{ft.})\left(\frac{\text{ft.}}{\text{sec.}}\right)\left(\frac{\text{lb.}}{\text{ft.}^3}\right)}{\frac{\text{lb.}}{\text{sec. ft.}}} = k\,,$$

which is an abstract or pure number. This is known as Reynold's number and named in honor of Osborne Reynolds, who made the extensive investigations from which he deduced the relation. Since it is dimensionless it may be used with any system of units. In C.G.S. units, d is the diameter in centimeters, v is the velocity in centimeters per second, w is the weight per cubic centimeter, and k is the absolute viscosity. Then

$$\frac{d\,v\,w}{k} = \frac{(\text{cm.})\left(\frac{\text{cm.}}{\text{sec.}}\right)\left(\frac{\text{gr}_3}{\text{cm.}}\right)}{\frac{\text{gr.}}{\text{sec. cm.}}} = k$$

Reynolds showed that with a certain given liquid and pipe there existed a critical velocity at which the flow changed abruptly from the laminar type, in which each particle moves with constant velocity parallel to the axis of the pipe, to the turbulent in which the particles move in irregular paths (Fig. 1). Except for unusual circumstances, such as the deliberate disturbance of the liquid, this critical velocity is proportional not to the viscosity alone but to the viscosity divided by the density. This introduces a new constant which has come to be called the kinematic viscosity.

Conditions in different tubes with different liquids will be the same when the Reynold's numbers are the same. There will be a change from laminar to turbulent flow value which experiment has shown to be when Reynold's number reaches a certain in the neighborhood of 2,100. If 2,000 may be assumed as a conservative value, then the critical value of v may be computed from

$$\frac{d\,v\,w}{k} = 2{,}000\,;\; v = \frac{2{,}000k}{d\,w}$$

The beginning of turbulence is hastened by disturbances in the liquid before it enters the tube, so that the exact criterion depends to some extent upon the end conditions of the tube, as well as the length. In any actual problem, if the type of flow appears doubtful, it is always safe to assume turbulent flow.

In order to co-ordinate stream line with turbulent flow the derivation of Poiseuille's law will be given. This law was formulated by a French physician while investigating the flow of blood through the capillaries.

Consider a portion of a cylindrical pipe of length 1 and radius R. See Fig. 1 (a). The difference between the unit pressures at A and B will be represented by p. It is this difference which causes the liquid to flow through the tube. Assume the flow to be such that every particle of liquid moves parallel to the axis of the cylinder with a constant velocity v. From symmetry this velocity is the same for all points lying in

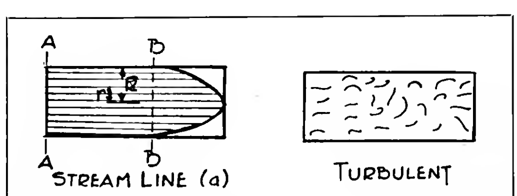

Fig. 1.

the same circle, so that the liquid may be considered as composed of hollow cylinders moving with velocities which are functions of the radii of the cylinders. The force exerted by the pressure p on a cylinder of radius r is

$$F = p\,\pi r^2$$

The resistance around the surface of the cylinder caused by the viscosity of the liquid will be given by

$$F_R = 2\,\pi\,r\,l \times k \times \frac{dv}{dr}$$

If the motion of the cylinder is not to be accelerated, that is if v is to remain constant, the forces acting on the cylinder must be equal and opposite, and

$$F = -F_R$$

Then

$$p\,\pi\,r^2 = -\,2\,\pi\,r\,l\,k\,\frac{dv}{dr}$$

The minus sign must be used, since v decreases as r increases. And

$$\frac{dv}{dr} = -\frac{p\,\pi\,r^2}{2\,\pi\,r\,L} = -\frac{p\,r}{2\,L}$$

$$dv = -\frac{p\,r\,d\,r}{2\,L\,k},$$

Integrating,

$$\int d\,v = -\frac{p}{2\,L\,k}\int r\,d\,r + C$$

$$v = -\frac{p\,r^2}{4\,L\,k} + C$$

In order to determine the constant C, it may be assumed that the velocity is zero when $r = R$. This is on the assumption that the liquid in contact with the pipe adheres to it. Then $C = \frac{p\,r^2}{4\,L\,k}$. The expression for velocity may then be written

$$v = -\frac{p\,r^2}{4\,L\,k} + \frac{p\,R^2}{4\,L\,k} = \frac{p}{4\,L\,k}\,(R^2 - r^2)$$

This is the equation of a parabola whose axis is parallel to the direction of v, while the axis of r is at a distance from the apex of the curve equal to $\frac{p\,r^2}{4\,L\,k}$, as can be seen by solving the expression for v when $r = O$.

Since v is the distance travelled in a unit of time, the particles of liquid which are in the plane A-A at zero time will be on the surface of a parabola after unit time. The volume of this paraboloid is the volume of the liquid, Q, which passes in unit time. The volume of this solid of revolution may be written

$$Q = 2\,\pi\int v\,r\,d\,r$$

Substituting the value of v,

$$Q = 2\,\pi\int\frac{p}{4\,L\,k}\,(R^2 - r^2)\,r\,d\,r$$

$$= \frac{2\,\pi\,p}{4\,L\,k}\int (R^2 r - r^3)\,d\,r$$

$$= \frac{\pi\,p\,R^4}{8\,L\,k}$$

As the flow is continuous, the volume discharged in any certain time is equal to Q t.

In the equation above, if Q is replaced by $\pi\ R^2 v$, where v is represents the average velocity in the pipe, then

$$\pi\,R^2 v = \frac{\pi\,p\,R^4}{8\,L\,k}$$

Solving this equation $r = \frac{8\,L\,v\,k}{R^2} = \frac{32\,L\,v\,k}{d^2}$.

In the above p is the drop in pressure measured in poundals. Since there are g poundals in a pound, if the equation is divided by g the pressure drop will be in pounds per square foot, or

$$p = \frac{32\,L\,v\,k}{g\,d^2}$$

This is the common form of expression for

computing the loss of head, or the head required to produce a certain velocity of flow through a definite length of pipe.

At the critical velocity the equations for stream line flow and for turbulent flow should give the same results. Thus

$$\frac{32\,k\,L\,v}{g\,d^2} = \frac{f\,w\,L}{d}\,\frac{v^2}{2\,g}$$

Solving for $f = \frac{64\,k}{d\,v\,w} = \frac{64}{K}$

The formula $p = \frac{f\,w\,L}{d}\,\frac{v^2}{2\,g}$ will give the same result as Poiseuille's equation if for f the value $\frac{64}{k}$ is substituted. If the values of f for stream line flow are determined on this basis, then

$$p = \frac{f\,w\,L}{d}\,\frac{v^2}{2g}$$

or the more common form

$$\frac{p}{w} = h = \frac{f\,L}{d}\,\frac{v^2}{2\,g}$$

may be used for both types of flow. If it is desired, however, Poiseuille's equation can still be used for stream line flow. In the diagram the values of f are plotted against the values of K for both types of flow.

Coefficients of viscosity are easily obtained from handbooks on Physics and Chemistry.

Illustrative Example. It is desired to pump water through a new 12 inch steel pipe 4 miles long with a velocity of 4 feet per second. What is the saving of Horse Power if the temperature of the water is raised from 50° F. to 150° F.?

Solution: At 50° F. the value of k = .00088, and Reynold's number is

$$K = \frac{1 \times 4 \times 62.5}{.00088} = 284{,}000$$

Since this number is much in excess of 2,100, turbulent flow will take place. The value of f corresponding to the above value of K is .019. (Fig. 2.) The head required to overcome pipe friction is

$$h = \frac{.019 \times 4 \times 5280}{1} \times \frac{4^2}{2\,g} = 99.72 \text{ feet.}$$

At 150° F., the value of k = .000291 and

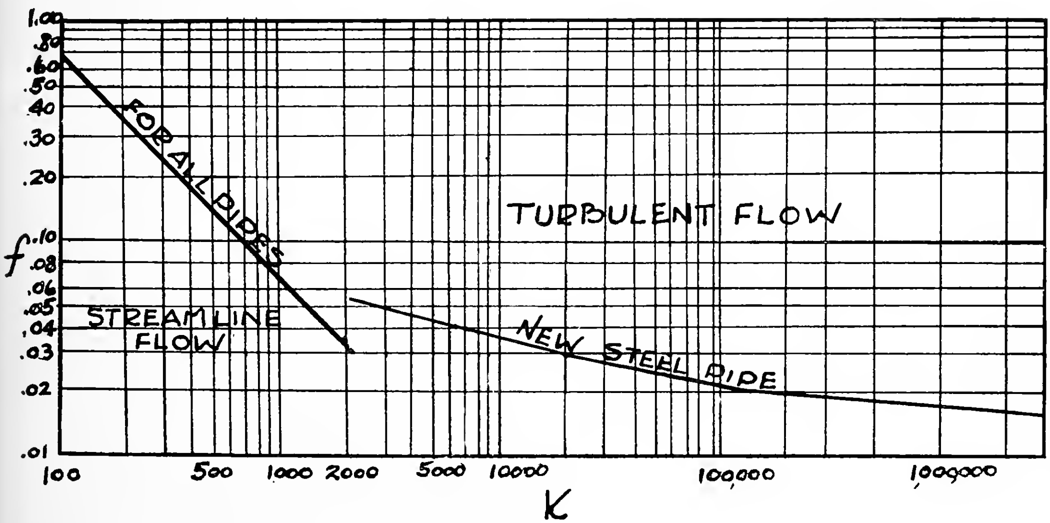

Fig. 2.

Reynold's number is

$$K = \frac{1 \times 4 \times 62.5}{.000291} = 859{,}100$$

This value indicates turbulent flow as before, and the value of f corresponding to this value of K is .0165. (Fig. 2.) The head required to overcome friction is

$$h = \frac{.0165 \times 4 \times 5280}{1} \times \frac{4^2}{2\,g} = 86.6 \text{ feet.}$$

The head saved is equal to 99.72 — 86.6 = 13.12 feet. This amount represents the head saved due to the change in the viscosity resulting from the increase in temperature. The quantity discharged is the same in both cases, and is

$$q = \frac{\pi\, 1^2}{4} \times 4 = 3.14 \text{ cu. ft. per sec.}$$

Weight of water,

$$W = 3.14 \times 62.5 = 196.3 \text{ lbs. per sec.}$$

The horse power saved,

$$\text{H.P.} = \frac{196.3 \times 13.12}{550} = 4.7$$

This example shows that the capacity varies materially with the change in the temperature of the water if the head is assumed to remain constant.

Illustrative Example. A new 6 inch steel pipe carries oil at a velocity of one foot per second when the temperature is 50° F. At this temperature the co-efficient of viscosity in English units is 1.63 and its weight per cubic foot is 60.5, what will be the velocity of flow if the temperature is raised to 150° F.?

Solution: Solving for Reynolds number,

$$K = \frac{.5 \times 1 \times 60.5}{1.63} = 18.55$$

Since this value is under 2,100, the flow will be stream line. The value of f either from the diagram or from the relation

$$f = \frac{64}{k}$$

$$f = \frac{64}{18.55} = 3.45$$

The head required will be

$$h = \frac{3.45 \times L}{.5} \times \frac{1^2}{2\,g} = 3.45\, C\, 1^2$$

where

$$C = \frac{L}{d\, 2\, g}$$

At 150° the value of K will have to be obtained by trial since it depends on the unknown value of v. A number of trials may be necessary in order to obtain the final value. Assume v = 9.6, then

$$K = \frac{.5 \times 9.6 \times 60.5}{.041} = 7{,}100$$

This value of Reynold's number indicates turbulent flow. The value of f from tables or from the diagram is .037.

$$h = .037\, C\, v^2 = 3.45\, C\, 1^2$$

equating the values of h for the two cases,

$$v^2 = \frac{3.45\, C\, 1^2}{.037\, C} = 93.3,$$

$$v = 9.6 \text{ ft. per sec.}$$

This value of v checks the assumed value. The example shows that by raising the temperature 100° the velocity of flow is increased from one foot per second to 9.6 feet per second.

Illustrative Example. A new 6 inch steel pipe line 5 miles long carries 60,000 gallons of crude oil per day of 12 hours, at a temperature of 50° F. The specified gravity of the oil is .8 and its co-efficient of viscosity is .0088. What pressure is needed in this pipe line?

Solution:

$$q = \frac{60{,}000}{7.5 \times 12 \times 3600} = .185 \text{ cu. ft. per sec.}$$

$$v = \frac{.185}{\frac{\pi}{16}} = .944 \text{ ft. per sec.}$$

$$K = \frac{.5 \times .944 \times .8 \times 62.5}{.0088} = 2{,}690$$

From Fig. 2, f = .05, and the required head,

$$h = \frac{.05 \times 5 \times 5280 \times \frac{.994^2}{2 \times 64.4}}{.5} = 35.0 \text{ ft.}$$

$$p = \frac{35 \times 144}{.8 \times 62.5} = 101.0 \text{ lbs. per sq. in.}$$

If a greater appreciation of the effect of viscosity is achieved from a reading of this article, then it may be possible that some of the discrepancies in the reader's work may be partially explained.

The following texts were freely consulted in preparing this article. Viscosity, by Hatchek. Principles of Chemical Engineering, by Walker, Lewis and McAdams. Hydraulics, by King and Wisler. Piping Handbook, by Walker and Crocker, together with numerous magazine articles. Figure 4 is from Hydraulics, by King and Wisler, but some modifications are introduced.

Starving Fire in the Home

By E. N. SEARL

CONCRETE floors! Steel frames! Masonry Walls! Incombustible roofs! Are these items in residence construction going to throw firemen out of employment and cause station houses to be boarded up? Possibly they may not function that successfully, but they undoubtedly will lessen the number of fires in homes which get started and lessen still more the damage done by those that do start.

Many examples of marvelously efficient fire-resistive residence construction can be thought of. A skeleton steel house could be built with concrete walls, concrete floors, flat roof with all members fireproofed, metal roof covering, rolling steel shutters over wired glass windows, and self closing fire doors at all entrances. To continue the foolishness, we could have asbestos lace curtains, do without rugs on the floors, frame photographs in gypsum blocks, have aluminum coated pianos, mattresses stuffed with cast iron shavings, etc., etc.

No. It seems as if there are limits to fire-resistive construction. In every case two items must always be considered: livability and reasonable cost. A glance at the above ridiculous suggestions show what can be covered by the phrase livability. It is not absolutely necessary that we have lace curtains at the windows, yet we have. We could exist without rugs on the floors. Conceptions of what makes a house livable change, but change very slowly. Now for keeping the cost within reason. Steel catalogs list members which can be used for the framing of pitched residence roofs, yet even a steel man admits that such framing is not always economically practical. These two factors of livability and reasonable cost must be kept in mind during any discussion of the fire-resistive values of residence construction.

The item which marks the greatest recent advance in fire-resistive home construction is the increasing attention being paid to possible incombustible floor constructions. Such floors include the use of steel beams, precast concrete joist, concrete slabs, steel joist, gypsum tongue and groove floor tile, and structural clay tile.

A poured concrete slab over precast

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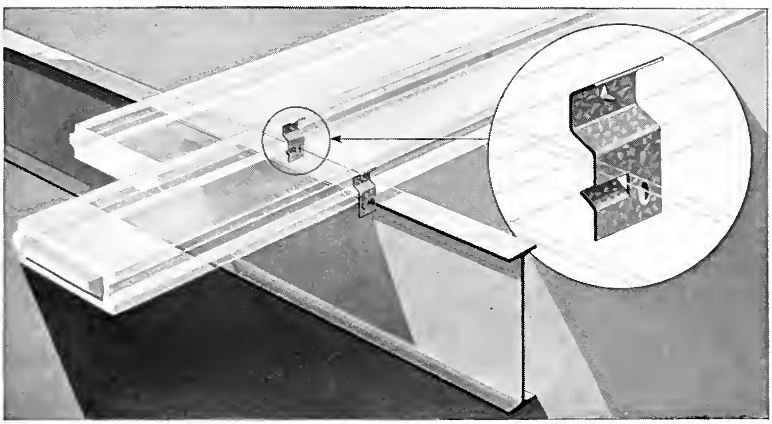
concrete joist, with reenforcing iron in both the slab and the joist, constitutes what is claimed to be an economical as well as satisfactorily fire-resistive floor. The joists are cast in metal forms with a standard type of horizontal and vertical reenforcing iron. Such joists may be obtained from the manufacturer. Wooden forms are put up, the reenforcing iron adjusted, and the concrete slab of about two inch thickness poured.

plastered direct, but is of necessity much heavier for equal strength than a concrete slab floor on steel beams or precast concrete joist.

A ribbed concrete residence floor consists of a one piece slab and joist construction. Although this type of floor is poured in one piece, the deep ribs act in a manner similar to joist in strengthening the slab. Such a construction gives an attractive beamed ceiling effect. A more economical



Tongue and Groove Gypsum Slab Flooring.

job is had by using hollow tile filler units between the ribs, putting the hollow tile units in place first and pouring the concrete about them. The economy lies in the use of flat forms for the concrete.

Steel I beams may be supported by bearing walls with a reenforced concrete slab poured over them. This necessitates encasing the beams in concrete or using a suspended ceiling of metal reenforcement and plaster.

A simple type concrete floor is a solid slab of uniform thickness, using two layers of crosswise reenforcing iron. This affords a flat under surface which may be

Gypsum has been used in a variety of ways in building construction because of its ease of handling and fire resistive qualities. It has recently been utilized in a precast tongue and groove floor slab

fastening to the steel flange with metal clips.

Light weight Haydite blocks are being experimented with and tested at the Portland Cement Association's laboratory. Coupled with the many advantages of concrete construction is the disadvantage of its heavy weight. It has been found that if a burned shale is used for the aggregate in the concrete instead of sand and gravel, a light weight yet durable block or joist results. This can be coated with a three-quarter inch layer of fine grained concrete, rendering the finished product as impervious to water as concrete can be. Such construction differs from the so-called "cinder block" in that the block or joist is absolutely free from combustible matter. Such Haydite construction can be used in the same manner as concrete, that is with reenforcing iron carrying the tension and the Haydite the compression.

Another development claimed by a manufacturer of a hard, pressed wall board is that the use of this board for concrete forms makes possible a smoother, almost glossy finish on the concrete. This should prove to be of much benefit in home construction.

Because of the location of the heating plant in the basement in close proximity to where old papers and magazines are usually stored together, with the occasional employment of basement garages, it is considered very valuable to have a fireproof floor cutting off the basement. In this condition it is not necessary to have a finished ceiling because appearance is of secondary importance. It is also desirable, although not to the same degree, to have fireproof floors at other levels. In this case the overhead appearance of concrete slabs, joists, hollow tile, or other building material is not very desirable. The usual answer to this problem is the suspension of metal lath or gypsum lath (a solid sheet of gypsum encased in a tough fibrous covering) and plastering as desired. In the case of exposed metal, the ceiling is necessary to protect the metal from fire.

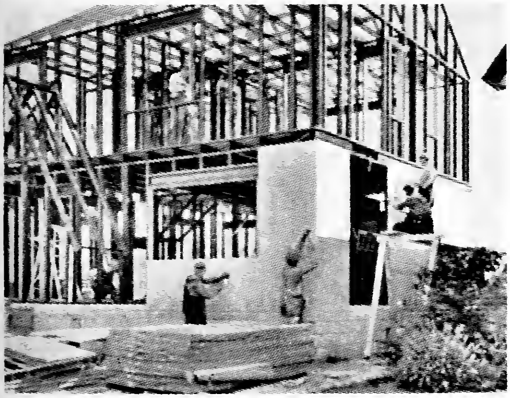
In the past one of the most formidable objections on the part of Mr. Public has been the preconceived notion that concrete or metal plate floors are hard to live on. This is because of contact with hard sidewalks. With the proper floor coverings, experience has shown that this is not so. Since terrazzo, marble mosaics, slate, concrete, tile, and art marble are furnished with such a freedom of design and color, and since coloring, waxing, and polishing of the concrete itself shows such promise of possibility, fireproof floors can be made not merely to supplement but to dominate the interior decoration.

Another basic change which seems due to come is the transition from combustible to noncombustible framing. A light steel member may fail as soon as a light wooden member when subjected to fire, but what is of prime importance, it will not support combustion. If nothing in the construction or contents of a building would burn, the susceptibility of the building to damage would be immaterial as no fire would exist. Although such a construction or occupancy is not practicable, any lessening of the amount of combustible material is an improvement.

Steel studs as well as steel joists are now

available in standard lengths for residence construction. One type of steel studding is made of light weight channels, spot welded back to back, thus leaving a groove in the center of the built up I beam. This curved groove forces the nail out of shape when driven into it, thus engaging the nail. Manufacturers claim that this type of fastening will hold four times as much load as a similar size nail driven in a wooden member. Window frames, door frames, braces, and such may be bolted to the studs much after the manner of a child's Meccano set. Such a construction, with masonry veneer on the outside and metal lath and gypsum plaster on the inside, is not strictly fireproof but is much superior to wood studding with similar outside and inside wall construction.

Several of the model homes at a Century of Progress utilize steel frames and various types of exterior finishes. One uses this type of studding just mentioned with enamel finished steel plates, backed up by one and a quarter inch solid Haydite blocks.



View of House Being Constructed of Grooved Steel Frame Members.

Another model home uses a synthetic building stone made of Bedford limestone, scrap, and shale. Thimbles are set into the inner surface of the block when the blocks are cast and can be thus bolted to the metal frame.

A couple more of the houses on display are all-steel, yet have no frame. They are built of prefabricated steel members, corrugated in such a way as to form the wall as well as take the load. Channel irons run perpendicular to the vertical wall members constituting the lateral bracing.

Common brick has a higher fire retardant value than any other building material, for it will not fuse at temperatures produced by natural fires. It does expand with heat, thus bulging towards the fire, but it is highly improbable that brick walls of ordinary dimensions would collapse because of this bulging.

Reenforced iron used in brick work has about the same advantages as iron in concrete. Brick possesses great strength in compression but is exceedingly weak in tension. By using reenforcing iron, brick cantilever arches may be employed. It might seem that brickwork could not be a homogeneous mass in the sense that concrete is, and that the mortar joint would present planes of weakness along which failure might occur. In practice, however, it has been found that this is not so.

Walls made of hollow concrete blocks have been used to a limited extent in residence construction. Such walls are highly fire-resistive, but not quite the equivalent of brick.

The modern tendency towards the incorporation of the garage as a part of the

house introduces another hazard. The garage should be cut off from the rest of the house in as fire-resistive a manner as practical.

A modern type of interior partition is light metal I beams, of the type known as metal lumber, for studding covered on each side with wire lath and a three coat job of cement or gypsum plaster. A partition of this construction has not yet been tested by Underwriters' Laboratories. It might not be fire retardant for any greater length of time than wood studs with similar protection, but by the elimination of that amount of combustible material, it lessens the length of time that the fire will continue to burn, thus lowering the hazard and susceptibility of the building to damage.

The resistance of a partition depends partly upon the nature of the lath used. Expanded metal lath is sheet metal, slit in a regular, alternate pattern and expanded by forces at right angles to the sheet. Thus the webs of the finished lath are at right angles to the plane of the sheet. The use of wire lath necessitates a three coat job of plaster for a good finish, with the plaster acting to stiffen the flexible wire lath. Wood lath usually requires but two coats of plaster as it is not as flexible as metal lath. A third type of backing is gypsum lath. This is a solid sheet of gypsum encased in a tough fibrous covering. Plaster may be applied directly to it, usually in three coats.

Fire tests by Underwriters' Laboratories show the superiority of metal lath to wood lath. A three coat job of gypsum plaster on metal lath used on both sides of the partition is rated as one hour fire retardant. A two coat job of gypsum plaster on wood lath used on both sides of the partition is rated as thirty minutes fire retardant. Although some of the credit for the better rating of metal lath partitions over wood lath is due to the thicker coating of plaster, metal lath has demonstrated greater resistance than wood.

Fire tests of gypsum lath partitions were made in the early part of 1933 by the United States Bureau of Standards. A half inch coat of gypsum plaster on gypsum lath used on both sides of the partition received a rating of fifty-eight minutes fire retardancy. When three-quarter inch holes were bored in the lath to furnish a better key for the plaster, the partition stood up under fire for an hour and twenty-eight minutes. The failure was due to either inability to sustain the load or to heat transmission, the one occurrence following the other so closely as to make it difficult to determine which was the primary cause. As a result of these tests, perforated gypsum lath is now commercially available.

The fire resistance value of the partition depends also on the plaster used. In the above fire resistance values of the various laths, gypsum plaster was used throughout in order that the laths might be fairly compared. Commercially, three types of plaster are used: sand-lime, gypsum and cement.

Sand-lime plaster has been the commonest type of plaster used in residences. When used on wood lath on both sides of a partition, it is rated by Underwriters' Laboratories as a twelve minute fire retardant.

Gypsum plaster is chemically $CaSO_4 \cdot \frac{1}{2}H_2O$ and sets by combining with water in the mixture, thus becoming $CaSO_4 \cdot 2H_2O$. This water of hydration possesses fire resistive value, since the temperature adjacent to the partition may not rise above 212 degrees Fahrenheit until all of the water of hydration is driven off. Used on wood lath on both sides of a partition, it is rated by Underwriters' Laboratories as a thirty minute fire retardant.

Cement plaster is chemically a mixture of silicates and aluminates of calcium. As a straight retardant of fire, gypsum plaster and Portland cement plaster are practically equivalent. However, cement plaster does have a tendency to blow off from metal lath due to rapid heat expansion.

Hollow clay tile are used to a considerable extent for interior partitions. An eight inch wall has a fire retardant value of about two and three-quarter hours. Since they usually fail first due to unequal expansion of the exposed and unexposed faces and consequent loss of the exposed face by cracking, a lessening of the thickness will not lessen to any great extent the fire retardant value except as it weakens the wall structurally. It is estimated that a three inch, non-bearing, partition wall will retard fire for about two hours. The chief advantages of this construction over other strictly fireproof partitions is its lightness of weight and economy of construction.

Another type of light weight fire resistive partition is made up of gypsum blocks two and a half feet long, one foot high, and three inches thick. Since gypsum contains considerable water of hydration which must be driven off before the heat can pass through the partition, it is highly fire resistive.

A detail of construction which is not receiving as much attention in residence construction is the use of metal trim in place of wooden trim. Metal doors, door frames, mouldings, casings, and such are used extensively in office buildings. Again the object is not to stop a fire by providing an impassable barrier but to remove fuel from the path of the fire, thus starving it. Although such trim can be had in plain colors or grained finishes, they still lack an appeal to a home furnisher. Livability, or public conception of what constitutes livability, always overrules fire retardant value in home construction. Ready built adjustable steel partitions which are extensively used in modern office buildings also lack the necessary appeal to become used to any great extent in residences.

Metal trim and metal furniture are used quite spectacularly in the model homes at a Century of Progress. For example, the Florida Tropical Home employs an aluminum staircase and railing running from the main living room up into the second floor. Surprisingly comfortable metal chairs and similar furniture decorate the interior of many of the homes. Vitrolite structural glass is used in the bathroom of the Rostone House. In this way the amount of fuel is lessened somewhat.

Ordinary gable roof construction consists of wooden rafters running up at an angle from the tops of the side walls, meeting at the ridgepole. The rafters are covered with wood sheathing parallel to the ridgepole. The roof covering is fastened

over the sheathing, thus completing the roof.

The character of the covering placed over the roof framing is exceedingly important. For a considerable length of time, the wood shingle roof was used extensively on all types of buildings. Now, however, it has little general use. The modern wood shingle is thin, having a fuzzy surface left by the machinery which manufactures it. After a dry period, this becomes like tinder. Such light fuzzy fuel will ignite easily and can be carried many blocks by the wind, where it may perchance land on another wood shingled roof, this being a principal factor in the spread of conflagrations. Their inherent hazard is so evident that many of the more important cities in the United States absolutely bar their use. New Orleans recognized this condition as early as 1790, excluding their use in some parts of the city in that year. Some work has been done in the matter of treating wood shingles chemically to decrease their fire hazard, but the results have not been very encouraging. However, some recognition of this work is given in some building codes.

Roof coverings accepted by Underwriters' Laboratories for various degrees of exposure are built up of various proportions and layers of asphalt, asbestos-felt, rag-felt and tar. Concrete tile, clay tile, and slate are also highly fire resistive.

Incombustible floors between masonry walls should confine any fire fairly well. Incombustible partitions and trim should restrict the available fuel and lessen the life of the fire. An incombustible roof should lessen the chance of fire from outside getting a start in this dwelling. Such a building is a substantial improvement over other homes.

Roughly twenty years ago the newly completed Burlington Building was hailed in Chicago as the forerunner of a new era in which fireproof construction had eliminated major fire loss in large office buildings. Precautions had been taken in the design and construction of the structure so that fire hazard was minimized. Eleven and a half years ago this same example of fireproof construction was damaged to the extent of $2,250,000.

A hot blast from a burning block to the west was carried by a strong wind across an eighty foot street, through unprotected windows into the building. The slight amount of combustible trim, furniture, and other contents became ablaze, heated the interior of the building as if it were an oven, damaged terra cotta, caused wired glass to flow out of the openings, wrecked some hollow tile partitions, blew metal filing cabinets out of shape, and in general wreaked havoc where havoc was not expected.

Profiting from this past history, we must guard ourselves from exaggerated delusions as to the extent to which modern homes are to be safeguarded by intelligent design and construction. We must remember that homes are not as fireproof as offices, that the small amount of combustible trim and contents in a modern office can generate an enormous amount of heat, and that therefore no home is fully proof against damage by fire.

The Automobile and Architecture

By PROF. W. LINDSAY SUTER

THE great changes caused by the automobile in our mode of living and in the material things all about us have been taken for granted much more than the equally amazing changes made by the manufacturers in the automotive products themselves, developments to which we now look forward from year to year. The social and economic influences of the auto are the subject of limitless study in themselves, but because of their close relation to the trend of architecture they must be mentioned from time to time in a discussion of the latter.

The first association of the words automobile and architecture naturally suggests the more direct influences, and brings to mind garages and filling stations. The first horseless buggies were kept in the stables or carriage houses of their owners, and repair work was usually done at the dealer's. Soon a few small public garages were established in suitable buildings, and the livery and boarding stables began to care for automobiles. As production increased, and as the car became something more than the plaything of the well-to-do, more facilities had to be provided for its shelter and care. There were constructed the first specially designed public garages, one story high with wooden trusses and skylights, giving clear, well lighted floor areas. These still serve their purpose in localities where the number of cars is nominal.

The multi-colored ramp garage came as a later development because of the greater demand for accommodation and higher land values. Built usually of fireproof construction, these buildings make use of a number of different schemes, the commonest of which is probably the one which divides the building in half, with the floor levels in the two parts staggered so that the ramps have an easy incline. As this latter type is naturally impractical beyond certain heights, during the last few years the skyscraper garage with elevators has been devised for areas where top notch land values prevail. Buildings in this class have been designed so as to be as economical of space and labor as possible; the handling of cars is done to a great extent by electrical and mechanical devices, and

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elaborate signal systems have been installed to indicate the location and movement of the autos. Provisions have been made for repair work, washing, greasing, and the sale of accessories.

Many of these larger garages have been carefully studied as to exterior treatment as well as interior arrangement, and compare favorably with the adjacent buildings. In fact, for a multi-storied garage in Boston, an architect was awarded, not long ago, the Harleston Parker Medal, a recognition given from time to time "for the most beautiful piece of architecture, building, monument or structure (built) within the limits of Boston".

Gasoline and oil have always been dispensed at garages, and for a time it was difficult to get them elsewhere. Here again the increased demand led to the establishment of filling stations, first in the towns and cities, and then throughout the countryside. Primarily agencies for the distribution of "gas" and oil, they have gradually increased their field to include the complete servicing of automobiles with the exception of mechanical work. At least one greasing pit and wash rack is now included in almost every filling station layout. The structures which have been built to date seem to serve their purpose of giving service admirably, but it is regrettable to note that the designs chosen for the majority have little or no artistic merit. In addition to the few pleasing buildings there are any number of Chinese temples, French castles, Spanish lighthouses, yellow balloons, glazed tile palaces and just plain shacks. The average will probably be higher as time goes on.

Along with the gasoline stations have sprung up myriads of refreshment stands. In spite of sums amounting to fifteen thousand dollars offered in prizes by Mrs. John D. Rockefeller, Jr., and Adolph Gobel, Inc., to determine the most attractive wayside refreshment stands, the ideas used here have been even more startling. They have run the whole gamut from glorified coffee pots through beehives to aeroplanes, with a few simple and attractive structures here and there.

Another institution dependent on the automobile is the roadhouse, but as most of these have been established in remodeled dwellings or barns they do not offer much in the way of architecture. A few pretentious places have been erected with gay and interesting dining rooms, spacious dancing terraces, and well laid out gardens, but they are rare.

Of much more interest to the architect are the many golf clubs, drawing upon the motoring public for membership, which have been established far enough away from the towns and cities to secure the benefit of cheap land values. These organizations have in recent years built some very comfortable and good looking club houses. Some of them have gone to the extent of providing, in addition to the usual facilities, such extras as swimming pools with cabañas, riding stables, guest cottages and boat houses, all offering opportunities for interesting architectural treatment in themselves and as a group with the main buildings.

The easy accessibility, due to the automobile, of areas surrounding towns and cities has created a demand for single fam-

ily houses "in the country", and has for the present put an end to the building of stately town houses and the smaller row houses for people of more moderate circumstances. A few years ago the spread of a suburban community was determined by the comfortable walking distance from the railroad station. Now one finds the commuter with his little house and half acre a mile or two from the railroad, to say nothing of the large estates still further removed. It is interesting to note the development of the garages belonging to these suburban homes. At first the automobile was kept in a small isolated garage, an outgrowth of the barn. Soon it was attached to the house and then enlarged to care for two cars.

This spreading of population has in turn led to the establishment of fair sized shops in strategic suburban locations. Within the last few years a number of department stores have been built in places where they would be economic failures were it not for the customers from many miles around who shop in their automobiles. Ample parking space is provided adjacent to these buildings which in themselves are complete establishments with carefully worked out circulation, elevators, display equipment, receiving and shipping facilities. The materials going into their construction are as fine and as carefully chosen as those to be found in their larger metropolitan prototypes. In more rural areas the same ease of accessibility has led to the establishment of small department stores in towns convenient to the farmer who prefers to buy from stock instead of from a mail order catalogue. The mail order concerns themselves have been quick to see this influence of the automobile, and have built retail shops of from one to three stories in hundreds of towns through the country and in the outlying sections of the larger cities.

However, in spite of the decentralization thus brought about, parking has become more and more a serious problem in the congested sections of our towns and cities. As a result hotels, department stores, theatres, and office buildings have taken steps to accommodate cars belonging to their tenants and patrons. Where possible this has been done by erecting garages with direct inside access to their buildings, and in other cases basements and sub-basements have been devoted to parking facilities. One large office building in Chicago is built with the rentable space around the outside and almost the entire central portion devoted to an elevator type garage, while a Detroit office building has its garage built adjacent to it with access at every floor. It is not uncommon now to see theatre and store buildings with adjoining wall-surrounded parking spaces where patrons can leave their cars. Some shopping centers built in the last few years, such as in the Country Club district of Kansas City, include as part of the general scheme enclosed and landscaped parking spaces accessible to all business establishments. Nevertheless the problem in most places is far from solved, as a Saturday night visit to the average business or theatre district will demonstrate.

Nothing as yet has been said of the buildings required for the manufacture

and sale of the automobiles themselves. Though the former are strictly utilitarian structures and outwardly differ little from many other factories, many of the large concerns have realized the advertising and good will returns resulting from architecture pleasing to the eye. One firm, carrying this idea a bit farther than the others, employed an architect several years ago to design all its factories and branches with such uniform and pleasing character that a motorist, upon seeing one of the buildings, immediately associated it with that particular firm and the quality of service in which it prided itself.

The simultaneous development of the motor car and of concrete construction has led to the erection of some rather interesting auto factories using this type of construction which allows great areas of glass wall, giving the interior light so desirable. The automobile manufacturers have also been aware of the desirability of orderly and well landscaped grounds to set off the architecture of their buildings.

The design of automobile salesrooms, while supervised in some cases by the large manufacturers, has not been given quite the same thought since most sales agencies are left to their own choice in the matter of building. The main idea underlying the design of many salesrooms has been either economy or the attraction of attention. The latter has resulted in "flashy" architecture, while the most successful examples seem to be those wherein the architecture has assumed the role of a simple but refined setting for the car, the real center of interest. Everyone, of course, is familiar with the more or less standard scheme with its great plate glass windows forming the front of an unobstructed display space behind which are the offices, storage, and service portions. The auto, being an outdoor vehicle, does not show to advantage when cramped; consequently the display rooms are of ample height, often with mezzanines used for offices. The proportion of sales, service, and office space varies with the type of branch or agency and the local requirements.

While the factories, assembly plants, and even district branches are situated on railroad lines, the retail sales agencies require frontage on motor traffic thoroughfares and group themselves along the well known "automobile rows." Many are the fine old residential sections along the boulevards of our cities that have been transformed in a few years into automobile districts.

The chances are that the motor vehicle will continue to effect architecture both directly and indirectly, though the changes will not be so rapid as in the past. A new element is already beginning to make itself felt with the growth of air transportation. It will be interesting to note the influence of the aeroplane on architecture as time continues.

Photoelectric Cells and Their Applications

By LEO C. GALBRAITH

FUNDAMENTALLY, the photoelectric cell is a two element light sensitive device which depends for its operation on the emission of electrons from a light sensitive surface. There are at present two general types of photoelectric tubes: gas filled and vacuum type. In both types light liberates electrons from the sensitive cathode. If a source of potential is applied to the tube to make the cathode negative and the anode positive, the negatively charged electrons will be attracted to the anode.

In the vacuum tube the flow of electrons from the cathode to anode constitutes the entire current passed by the tube. In a gas-filled tube, however, the maximum current that can flow is much greater than that represented by the number of electrons liberated from the cathode. The reason for this is that the electrons, in going from the cathode to the anode, collide with the atoms of the inert gas introduced in the tube, and liberate from the atoms additional electrons which are also attracted to the anode. This phenomenon is called gas amplification, and its use makes possible the construction of photoelectric tubes capable of passing approximately ten times the current per unit light flux that can be passed by vacuum tubes.

The number of electrons emitted from the sensitive cathode, that is the current passed, is dependent on the amount of light on the cathode. For the vacuum photoelectric tube the relation between light flux and anode current as seen on a graph is a straight line; for the gas filled tubes this line has a slight curvature. This proportionality of current to light flux is the most important characteristic of the photoelectric tube, and it is upon this characteristic that most of its applications are based. Fig. 1 shows the anode current characteristic curves for gas-filled and vacuum photoelectric tubes.

Vacuum cells containing no gas filling are preferable in everything but sensitivity. If accuracy is required, efforts should be made to use lights strong enough to give the right current in a vacuum cell, and to use that current to the best advantage. For most industrial purposes, and especially in television where sensitivity rather than ac-

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curacy is the first requisite, gas filling is necessary.

The choice of the nature and pressure of the gas requires care which is exercised by the research departments of the manufacturers. Osram cells are actually filled with argon gas to a pressure of about .15 mm.

The primary current is proportional to the amount of light falling on the cathode. The constant ratio of the current to this amount is called the emission. The emission varies greatly both with the material used on the cathode and the quality of the light. The light sensitive metals used on the cathode may be potassium, sodium, rubidium, or caesium.

As the emission of electrons varies greatly with the metals used on the cathode, it is essential that we know something of the sensitivity of different metals to different wavelengths. Potassium is sensitive to blue violet of the spectrum and completely insensitive to wavelengths above 4400 Au., but can be made equally sensitive to red light. Rubidium and sodium are also sensitive in this region. Caesium is more sensitive to yellow light at a wavelength of 5500 Au. Lithium, sodium, and potassium are all sensitive to ultra-violet light. Of all metals now used as cathodes, caesium makes the best approximation and potassium on copper about the same, although its output is larger and more regular.

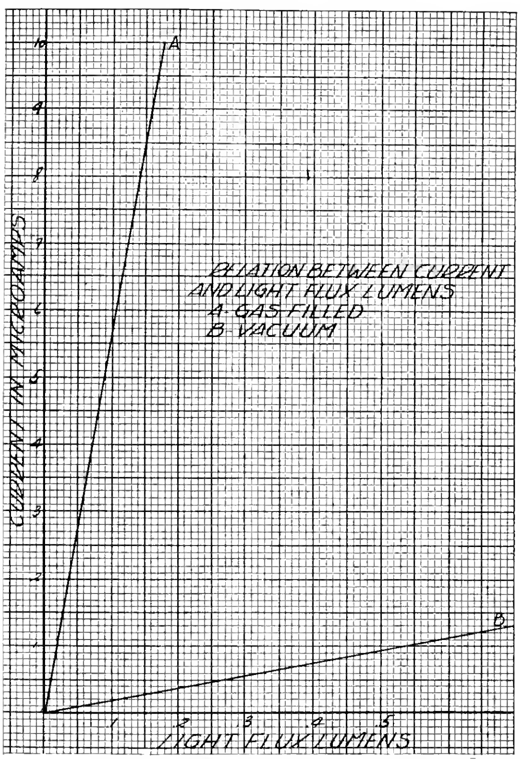


Fig. 1.

It is interesting to note the immense superiority of sunlight over artificial light. The great difference in the currents obtained from sunlight and artificial light is probably due to the larger proportion of blue light to which the metals given are chiefly sensitive.

In a vacuum cell, the size and form of the bulb and the electrode make no effect upon the current obtained with a given amount of light although, if the cell is exposed to diffused light, the larger cathode will give the greater current. A cathode that is not part of the wall of the bulb is more regular in action, and this form of construction is adopted in vacuum Osram cells. In gas filled cells, size and form make a difference to the magnification of the primary currents by the gas filling. The standard gas filled Osram cells have electrodes that are approximately parallel planes contained in a bulb 5 cm. in diameter.

The method of preparing the cell is to

clean the potassium and free it from paraffin as far as possible before introducing it into the tube or bulb, which is then sealed off. The whole apparatus is then evacuated by a vacuum pump which is kept in operation for the rest of the process. The potassium is melted and the tube turned until the potassium runs down into the bottom of the cell and flows around the cathode. The potassium is next treated to render its surface absorbent. Pure hydrogen is introduced into the cell at a pressure of .05-1 mm. of mercury. A discharge from a small induction coil (½ in. spark) is then sent through the cell until the potassium is a deep violet in color. After this the hydrogen is pumped out and pure argon gas is introduced at a pressure of .75 mm. The sealing of the tube completes the process of manufacture.

Although the current through the photoelectric cell increases when the light on the cathode increases, the current obtained with such light is very small, not exceeding a few microamperes. To be readily useful, the minute current must be amplified sufficiently to operate relays, ordinary recording and indicating instruments, or other devices. The most commonly used systems employ the three element thermionic amplifier tube similar to the type that is used as a radio amplifier. This type of tube will be referred to as the pliotron.

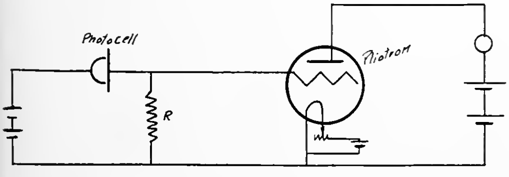


Fig. 2.

The fundamental circuit for this amplification is shown in Fig. 2.

The circuit is so arranged that a change in the photoelectric tube changes the grid voltage of the pliotron. This results in a proportionate change of the pliotron plate current which is strong enough to operate relays, etc. This type of circuit may be employed on alternating or direct current. Because of the rectifying action of both the pliotron and the photoelectric cell, the a-c current is active only when the respective anodes are positive. A half-wave pulsating direct current is the result. The effective value of this current depends chiefly on the illumination on the photoelectric tube, but it is also affected to a certain extent by variations in the supply voltage.

Applications of the photoelectric cell at the present are many and varied. Due to the great improvement that the cells have undergone during the past few years, designing engineers are now using this piece of apparatus as much as possible in the development of new machinery. It would be impossible to take up all the applications of photoelectric cells in industrial use.

The further development of the television from its present day state will call for large scale manufacture of the photoelectric cell for that purpose only. At present the picture or living image to be transmitted is scanned by a rapidly moving but very slender beam of light. This beam comes from a powerful arc lamp, condensed by lenses, and transmitted through small, spirally arranged holes in a rapidly revolving disk so that a small

beam of light traverses the subject in varying straight lines that cover the whole subject in 1/7 second or less. Each little illuminated part of the subject then reflects scattered light and part of this falls on a set of photoelectric cells screened from outside light. This causes tiny currents to be set up in the cell, which are amplified and transmitted from an ordinary radio station. The receiving of the image is exactly the reverse of the process.

A number of photoelectric equipments have been built for color analysis and color matching. The recording color analyzer and one type of color comparator will be described here.

The color analyzer is a device which automatically draws for permanent record the color curve of a sample. The device is so constructed that the light reflected from a surface of a solid material, or the light transmitted by a transparent substance, may be recorded on a curve. By means of a flicker disk, the photoelectric tubes receive alternately light reflected first from the standard then from the sample. A recording pen indicates on a chart the position of the shutter at which the light from the sample equals that of the standard. This device is of great assistance to those working in color, as it is possible to get an absolute identification of a color by its curve.

The color comparator is a much simpler device than the color analyzer. Its most important use is in matching colors. The device consists of a simple optical system and amplifier with a milliammeter which indicates the difference between light reflected from two specimens placed in the sample stand. The accuracy is as good as that of the eye, and in some color regions it is much better.

By far the greatest number of applications of the photoelectric cell are those in which an electric circuit is opened or closed in response to a certain change of illumination on the tube.

Lighting control whereby lights are automatically turned on and off as daylight decreases or increases is one of the most interesting as well as important application of the photocell to automatic control. There are many kinds of lighting that can be controlled to an advantage in this manner.

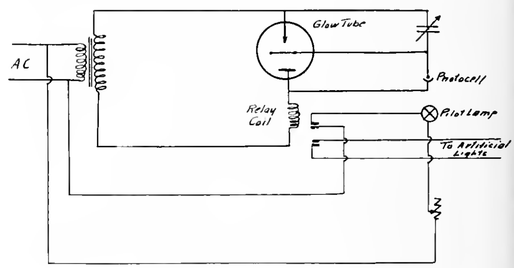


Fig. 3.

The simple circuit given in Fig. 3 is used in the application.

The photocell is dimly lighted by a pilot lamp but is actuated by daylight or artificial light if used in interior. It passes a slight current continually which is amplified discontinuously by a grid glow tube. By this it is meant that the grid glow tube passes no current until the illumination of the cell falls below a predetermined value, then the tube breaks down (passes current) and the relay contacts close turning on the lights. At the same time the pilot lamp is turned off in order that the artificial light which falls on the cell may not

turn on the lights again. With the lights turned off, if daylight should return, the light will be turned off and the pilot lamp lighted. Very little maintenance is required on the lighting control unit other than to wipe off the glass window occasionally. Replacement of tubes is required only once a year, and sometimes less often.

Counting is one of the Applications which is receiving a great deal of attention. Lamp bases, for instance, are so light that it is difficult to count them mechanically. The bases are lined up and separated by a device, and then pass between a light source and a cell. A light relay is operated as the light beam is interrupted. The contacts of the light relay close the coil circuit of a magnetic counter. These bases can be counted accurately up to three hundred a minute. Photoelectric counters are being used commercially in counting automobiles, people, steel bars and billets on rolling machines, drops of oil in an automatic oiling machine, etc.

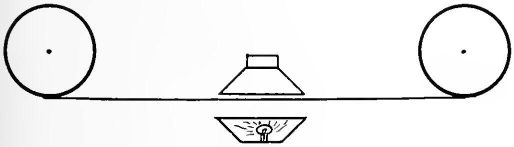


Fig. 4.

The Paper Break Indicator and Recorder is an application also in great use. The light sensitive device is mounted on the paper machine to operate when the paper breaks. Fig. 4 shows the way it is installed. It can give indication and alarms to the operator and a record of the time of duration of the break can be kept for later inspection by those interested in the continuous operation of the machine. A great amount of time and material can be saved by this device because less time is consumed before the operator realizes that a break has occurred. On the wet end of the machine, the paper break indicator can be used to turn on the water spray automatically when needed.

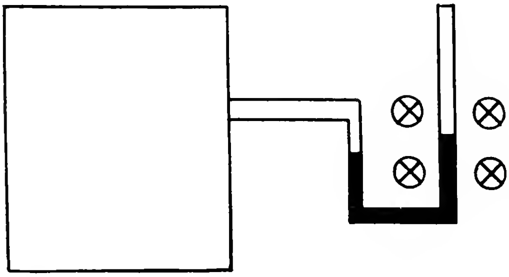


Fig. 5.

Accurate Pressure Control is accomplished as shown in Fig. 5.

Here two light sensitive devices operate as the pressure rises and falls. The pressure is measured by a Manometer or other similar instrument. The column of mercury or colored fluid is used to make and break the beams of light. As the column rises and falls the proper light beam is made or broken. The corresponding relay operates to increase or decrease the pressure so that it will remain between the extremes of allowable variations.

While the above examples of the application of the photoelectric cell are only a small number of those that are in use, an attempt has been made to give the reader a good idea of the uses that this device has in the industrial world.

THE ARMOUR ENGINEER

Student Technical Publication of Armour Institute of Technology

VOLUME XXV | MARCH, 1934 | NUMBER 3

The New Staff

THIS issue of the "Engineer" is the first by the newly elected staff. Those men composing the personnel of the retiring staff will remain in an advisory capacity for the remainder of the year.

The new men have a standard set for them to which they will strive. The "Engineer" has improved with great rapidity during the past few years, and the improvement must be given an added impetus by those now in charge.

The old staff has done a very creditable job with the magazine during their year, and it is fitting that they should finish a year of such success by tutoring the men who follow in their footsteps.

The CWA Versus the College Graduate

DURING the siege of depression which has shrouded the world, countless men have been wrested from work. At last a means of employment has been found and many of these are again earning wages. The CWA and other movements inaugurated by the government seemed to be a marvelous solution to the problem confronting the nation. The question rests in the practicability of the CWA. Trained men are receiving pay for "working", but are the projects on which they work worthwhile? Men are employed by scores to resurface streets, clean up the highways, et cetera. When they are finished, have they succeeded? In some cases they have, but in the majority they have not.

Why should money, which has come from taxation of the people, be thrown to the skies? Would it not be better to spend such money on projects that would require the skill of the men employed? Men who have graduated from college are in the streets with shovels. Surely their talent might be used to advantage elsewhere.

THE GUEST EDITORIAL

Broadening the Engineer's Outlook

A THOUGHT which is by no means original, but which can hardly be too often reiterated, is that one which emphasizes the need for a broader outlook on the part of engineers, particularly college bred engineers. The rigors of a first class college course in engineering are well known; due, no doubt, largely to this heavy schedule, graduates of our engineering schools frequently appear to possess many of the attributes of slide rules and few of those characteristics essential for the successful handling of broad problems.

It takes a good man to assimilate a first class college course in engineering; a better man to not only "pass" in his engineering courses but to also seek out opportunities for broadening his viewpoint, thus providing a sound foundation upon which the structure of his technical knowledge can rest.

Until our engineering schools develop some means whereby curricula may be materially broadened, it is up to the individual to lay more stress upon those purely "cultural" activities as distinguished from the "technical" subjects, the bare requirements for a diploma.

—J. V. Parker

Manager,
Western Actuarial Bureau.

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

Industrial Carbon

By C. L. Mantell
Van Nostrand, $4.50

RECOGNIZED by the society woman as a sparkling gem, and by the ordinary man as that black, dirty material which clogs the chimney of his furnace, carbon in its various forms is becoming one of the necessities of modern civilization. One may gather some idea of its importance by considering the fact that, in the United States alone, over one hundred million dollars worth is produced annually. Valuable as carbon is, however, little attention has been paid to it in literature until recent times. The subject also awaits development along other lines, for, says Dr. Mantell, "Carbon industries are a fruitful source for industrial research, not only because of the low yields of some branches but on account of the fact that so very little work has been done in proportion to the amount of improvement possible and very probable".

The subject matter of the book can be divided into several classifications, such as the elementary forms of carbon, carbon pigments, absorbing carbon, and products manufactured from carbon. In the first division lies the diamond and graphite. The former, aside from its value as a gem, is used in the cutting of glass and the boring of oil wells. The exact antithesis (with respect to hardness) of the diamond is graphite, the uses and manufacture of which are described in great detail in this volume.

The second classification includes a description of the uses of carbon as a pigment for paints and inks, which owe a good deal of their smooth-flowing qualities and their denseness to that substance. A detailed account of the ways in which carbon is employed in gas masks and as an absorbent of various disease germs constitutes the next division, while the final section of the book is devoted to describing the manufacture of carbon into brushes for electric motors, arc lamps, telephone transmitters, etc. A reference table giving the various physical and chemical properties of the substance, as well as many diagrams and illustrations, are also included in the volume.

Electron Tubes and Their Application

By John H. Morecroft
Wiley, $4.50

QUEER as it may seem, electron tube is not of value just to the electrical engineer alone. Its employment as an automatic control results in more uniform products than those obtained under human supervision, thus proving a boon to the mechanical engineer. In the field of chem-

istry and metallurgy its use as a control for smelting, purifying, and annealing processes, as well as a remote control, has made the electron tube a particularly valuable tool. Geologists and mining engineers also find the assistance it renders in their field of great importance. In general, it has been said that there is hardly any new scientific process which can be developed that cannot in some way be improved through the use of the electron tube.

It is in accordance with these facts that the author of "Electron Tubes" has given the book the ability to serve in perhaps three capacities. The volume can be of value to the practical engineer who is endeavoring to better some process in which he is interested. The student of engineering will find that the book will also serve as a text, for the material contained in it constitutes approximately what the average course should cover. That it may also be used in the capacity of a reference book need hardly be mentioned.

The subject matter discussed in the volume may be divided into two divisions: namely, the extraction of electrons from metals and the methods of utilizing them, and the characteristics and uses of all types of commercial tubes. The following subjects are discussed in particular: constitution of matter and the removal of electrons from it, space charge and its effect, hot-cathode vacuum and gas-filled tubes, photo-electric cells, special electronic devices, the uses of valves, the triode or three-electrode tube, and various uses of electronic apparatus. Tables, diagrams, photographs, and graphs also enhance the book.

The Universe of Light

By Sir Wm. Bragg
MacMillan

JUST as the upper stories of a building cannot be constructed until the foundation has been laid, so the study of a science cannot progress unless some theories are developed beforehand. Thus the subject of light is based upon the corpuscular and wave theories evolved by Newton and Huygens in the seventeenth century. Even though new hypotheses may be developed eventually, the more recent ones cannot be thoroughly understood until a knowledge of their precedents is gained. The author of this volume has, therefore, given us a history of these two theories and the observed phenomenon of light on which they are based. His style of writing is such that even the layman who has had but little foundation in the way of physics may understand it.

The book opens with a statement and analysis of the two theories, and a description of such common subjects as reflection, dispersion, images, reflection at curved surfaces, binocular vision, and pinhole images. Next in order the author takes up the human eye, describing in detail how confusion on the retina is avoided, optical defects of the eye and remedies for them, astigmatism, various optical illusions, persistence of vision, etc. Under the subject of color the spectrum, the range of wavelengths, reactions of the eye to color, color blindness, complimentary colors, the origins of color, and the colors of the sky are discussed. Other subjects included in the volume are the polarization of light, light from the sun and stars, and Röntgen rays.

Twenty-six full page photographs add materially to the interest in the book, and the fact that several of them are beautifully colored also enhances its value.

The Early Years of Modern Civil Engineering

By Kirby and Laurson
Yale University Press

HISTORIES relating to the subject of civil engineering are very few and far between. True, many biographies of men who might have been termed civil engineers in ancient times have been written, but quite a number of these accounts are in foreign languages and the others have so little connection with each other that it is difficult for a student of civil engineering to find even a rather complete history of the subject. With this fact in mind the authors of this volume have attempted to give a connected account of the most important events in civil engineering history.

The subject, as one may easily imagine, is a large one. To take up in detail the life of each one of the early engineers and his connection with the matter would require many volumes, so the authors have contented themselves with giving an account of the more modern developments, especially during the period of the eighteenth and nineteenth centuries, when there was little literature to be had in the way of handbooks, textbooks, and magazines.

The text of the book presupposes at least some knowledge along the line of civil engineering. The subjects discussed include: surveying, canals, roads and pavements, railroads, bridges, tunnels and subways, waterworks and water power, sewers, river and harbor improvement, and materials. Under each of these headings the origin and a description of the various kinds and means of construction are given.

For the reader who desires to go further into the subject a well-organized and selected bibliography is given at the end of each chapter. At the close of the volume there are also several very helpful lists of other books, addresses, papers, and periodicals concerning the subject of civil engineering.

THE COLLEGE CHRONICLE

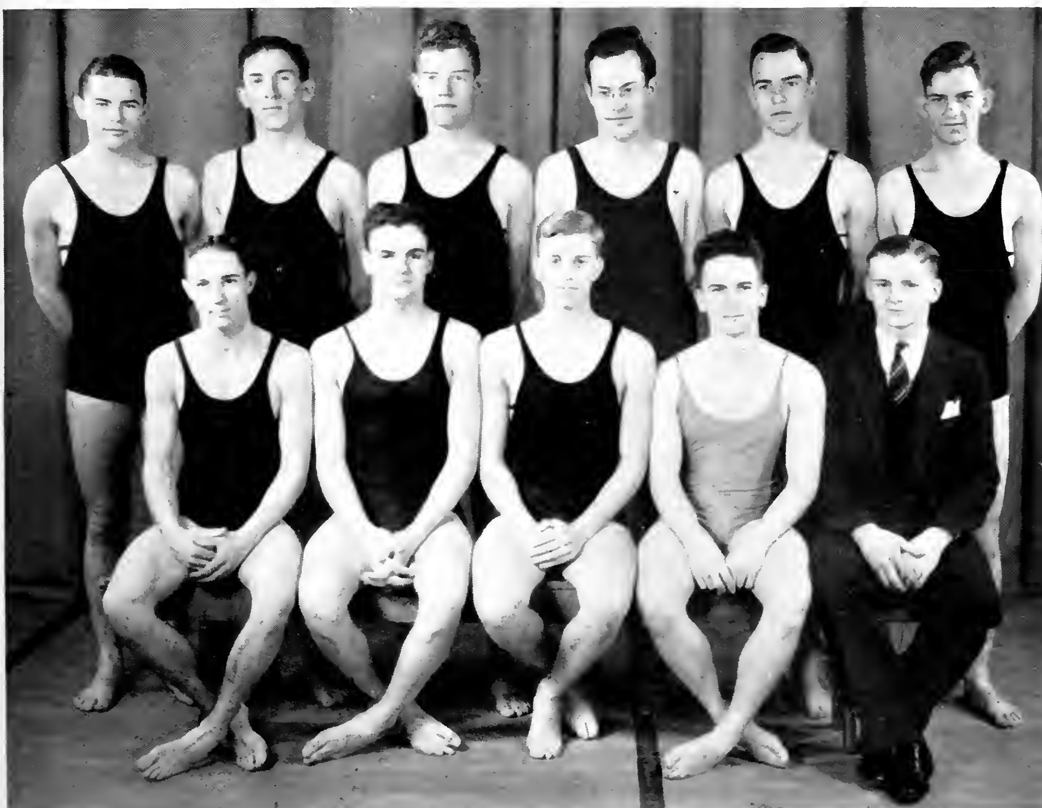
NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Swimming

THIS season marks the first for swimming as a major sport at Armour. As a result, this year's competition will be considerably stiffer than formerly.

Meets have been held with George Williams, Northwestern, and Loyola. The teams on the schedule who have not been faced are Morton, Wisconsin, and Chicago.

The team has been crippled by the loss of its sterling leader of last year, Roy Carlstrom, but with Kolve, this year's captain, setting the pace, the fellows are ready to swim to victory at any cost.



ARMOUR'S SWIMMING TEAM *Photograph by Marshall.*

Front row (left to right): Reed, J. Ahearn, Cap't Kolve, Tallafus, Mgr. Suman. Standing: Moore, Berstein, Luce, Burson, Knaus, Davison.

Armour Invitational Relays

ON March 17th, the sixth annual Armour Invitational Relays will be held in the University of Chicago field house. Coach A. A. Stagg, Jr., coach of the Armour track team, is in charge of the arrangements for the relays.

In the past few years the Armour Relays have come to be an important date in the track schedules of middle western universities and colleges. Last year there were about forty schools competing and it is expected that there will be at least an equal number this year. Entries will probably be received from all of the Big Ten schools, Notre Dame, Marquette University, Michigan State, and numerous smaller colleges.

Competition in the meet is divided into two classes, college and university, on the basis of the enrollments at each school. There are sixteen events scheduled. One new event is a one mile relay for members of the football squads of the competing schools. Feature events on the program are the university one mile and two mile relays, and the college one mile relay and sprint medley relay.

[Armour holds the meet record for the shot put. This record was established in 1930 by Donald Paul. His toss was forty-six feet and seven inches.] This year our hopes are placed in Capt. George Nelson. His enviable record this season makes us expect a great deal from him.

Basketball

THE Armour basketeers have just completed one of the most strenuous seasons in the history of the school. Considering the class of opposition with which they have competed it has been successful. Games have been played with DePaul, North Central, Ypsilanti, University of Chicago, Augustana, and other teams which have rated well.

Coach Kraft succeeded in developing a quintet which was very smooth and deceptive. Captain Ray Pflum at guard showed a good eye, and was a pillar of strength on defense. Al Lauchiskis on the pivot line flanked by Heike and Dollenmaier presented a front line that scored almost at will; while Pop Warner, at the other guard, was a most able partner to Pflum. Christoff and Lucas played some fine ball when they were called upon. Merz, Doane, Rummel, and Levy proved themselves worthy members of the squad.

Wrestling

THE wrestlers have not been fully organized into a group yet, as the tournament has not been finished.

There are many new men trying out for the team and Coach Weissman should find some good prospects among them. The team's strength has been severely lessened by the loss of Captain Frank Talaber, who has enrolled at Northwestern University.

Manager Frank Koko has not yet made out the complete schedule for the coming season. This difficulty is due to the fact that few of the smaller colleges are supporting wrestling teams.

There are many openings left for new men, and all those who like to wrestle should come out for the team.

Boxing

If you happen to pass the gym on a Tuesday or Friday night just take a look in and see some real labor. The leather pushers are getting down to serious training as the coming season promises to be a busy one.

Coach Weissman has been grooming his men so that they will be in good condition for the oncoming meets which Manager Jim Castanes has arranged on his schedule. The schedule which is not yet completely drawn up is as follows:

Morton at Armour—March 16.
Armour at Culver—March 31.
DePaul at Armour—April 6.

Negotiations are under way for a meet with Northwestern early in April. This promises to be a lively series of encounters as the purple scrappers are well experienced.

The annual tournament has been completed and Coach Weissman has some good material to pick from among the winners of those contests. The boys who succeeded in defeating all their opponents are:

Goldman, 120 lbs.
Reed, 135 lbs.
Geerhardts, 145 lbs.
McAuliffe, 160 lbs.

As there are still some men left from last year's team, Coach Weissman should have no difficulty in arranging his men throughout the different weight divisions to form a well balanced group.

Most of Tech's hopes are pinned on the services of Captain MacDonald, Smith, McAuliffe, Gerhardts, Goldman, Breh, Marcus, Suman, Anderson, and Norriss. These are the men that will endeavor to punch their way through to a successful season.

Phi Lambda Upsilon

The pledges of Omicron chapter have been active the past two months preparing assigned themes and decorative paddles as prerequisites for their coming initiation.

A pledge meeting, held last December, was enjoyed by all members present, much to the discomfort of the pledges.

The coming initiation will be attended by the faculty members and several alumni. It will be held in one of the local fraternity houses.

Honor "A"

On November 1st eight pledges were inducted at a smoker held at the Theta Xi house. Those pledged were:

E. Adamec.
W. B. Ahern.
J. A. Bacci.
E. J. Baumel.
L. W. Davidson.
A. Kulpak.
A. Lauchiskis.
G. W. Mayer.

The above men were honored at an initiation banquet held in the Boulevard Room of the Stevens Hotel on December 20th. Faculty members who attended in a very jovial mood were Prof. Schommer and Coaches Weissman and Kraft. An enjoyable evening was spent under the spell of Charlie Agnew's great band. A certain

songstress, whom George Reed found very entertaining, graciously offered her autograph. To conclude the evening our pledges rendered "The Fight Song" and "Alma Mater". Judging from their evident success, the Mills brothers' fame is in jeopardy.

Chi Epsilon

PROFESSOR S. M. SPEARS was initiated into Chi Epsilon last January. The fraternity now has eight faculty members and sixteen active student members.

Alpha Chi Sigma

ON February 2nd Alpha Psi of Alpha Chi Sigma held an installation of officers, naming:

J. Russell Lang, Master Alchemist.
Walter E. Gundersen, Vice-Master Alchemist.
Rolland McFarland, Reporter.
Raymond W. Marty, Recorder.
Daniel J. Mullane, Treasurer.
Robert H. Schorling, Master of Ceremonies.
James J. Doheny, Alumni Secretary.

J. R. Lang was elected as the delegate from Alpha Psi to attend the Alpha Chi Sigma convention to be held in Indianapolis this coming summer.

Alvin J. Ragan, '36, was pledged on December 21st in the fraternity rooms.

Scarab

EDFOU Temple of Scarab held its annual initiation of the Architects Club of Chicago, 1818 Prairie Avenue, on January 18th. At that time ten men were honored by membership. These men were:

A. J. Adreani, '34.
F. C. Bartlett, Jr., '34.
J. A. Benya, '34.
R. H. Cheatham, '34.
R. E. Esbensen, '35.
H. O. Gerhardt, '34.
L. O. Johnson, '35.
H. L. Martorano, '34.
J. S. Sandstedt, '33.
C. T. Seaberg, '34.

A short time after the initiation the first monthly banquet of this semester was held. This time the banquet took place in the Old Town Tap Room of the Hotel Sherman. A good crowd enjoyed the banquet and festivities that followed.

American Institute of Chemical Engineers

BETA chapter of the A. I. Ch. E. will have the pleasure of listening to a number of well known chemists and chemical engineers in the near future.

A trip to the testing laboratories of Montgomery Ward and Company will be an outstanding event on our spring program. The members are also looking forward to the spring smoker to be held in May.

American Institute of Electrical Engineers

A LARGE crowd attended a meeting of the Armour student branch of the A. I. E. E. on December 15th. The program consisted of motion pictures presented by the Leeds and Northrup Company. The pictures pertained to the different types of electrical measuring instruments.

The American Society of Mechanical Engineers

THE Armour Branch of the American Society of Mechanical Engineers, with a large and active membership, is continuing in the second semester to have a great number of interesting and instructive meetings.

One of the largest meetings of the year was held in the Assembly Hall on January 22nd. Mr. Van Haitsma from the Boeing Aeronautics School, Oakland, California, addressed the students and presented several films. His topic was the "Opportunities for College Trained Men in the Aviation Industry". Following the talk he showed some films on the historical development of aviation, the manufacture of Pratt and Whitney engines, and the work of the Boeing School of Aeronautics. The meeting was well attended by the Junior and Senior Mechanical classes and by many visitors.

A business meeting was held on February 9th, for the purpose of taking action on some important current matters. The president of the local branch, R. W. Suman, was elected to be chairman of one of the sessions of the coming annual Student Conference which will be held in Chicago.

Two important meetings which have been arranged in the near future are one at which Mr. Abbott, chief engineer of the Commonwealth Edison Company, will speak, and the joint meeting of the technical societies at which the Link Belt will present a lecture on "Handling of Materials".

An inspection trip that will last all day and will include visits to several large manfacturing plants on the south side of Chicago is now being arranged.

Western Society of Engineers

MR. E. J. BLIX, prominent consulting engineer of the Mississippi Valley Steel Structural Company, was the guest speaker at a recent meeting of the Armour branch of Western Society of Engineers. Mr. Blix spoke on the design and the construction of the Chicago World's Fair Sky Ride, a project for which he was in a large measure responsible.

Mr. Blix stated that the initial impetus for this undertaking came from the need for some major, distinguishing feature at the fair grounds around which advertising might be framed.

The structure was not an experiment though it is novel to this section of the country. An interesting parallel brought out by Mr. Blix was that in total sympathy with the function of the fair as a business revival measure, the investment entering into the actual construction of the ride was forthcoming from the several companies which took part in the project principally because it enabled these companies to maintain their working capacity during its erection. Incidentally, the net income from the Sky Ride up to the present has just reimbursed these participating companies for their initial investment.

Plans are now in progress for the annual Spring Smoker. The date will be announced soon.

ALUMNI NOTES

NEWS OF ARMOUR ALUMNI ASSOCIATION AND OF ARMOUR GRADUATES

Alumni Luncheons

TIMES are improving so that alumni luncheons may be resumed in the spring. These monthly luncheons had to be abandoned two years ago due to the stress of the times and the resultant lack of attendance. However, with many of our engineers returning to work and more being placed each week, due to the efforts of Mr. Lanigor of the Placement Bureau, it is high time that new contacts should be made and old friendships renewed through these alumni luncheons.

The Class of 1909 will hold its reunion this spring. No doubt the '09 class will appear at a joint banquet with the general body of alumni. This banquet will be held about June 1st and the efforts of the officers will be directed to obtain a large attendance.

FRED D. PAYNE, Fire Protect of the Class of 1928, became the father of an eight pounds and fifteen ounces baby December 17th. The child was christened David Louis. Fred, who was captain of the track team while in school, is employed by the Indiana Inspection Bureau.

ARMOUR alumni in the vicinity of Indianapolis gave a smoker for Prof. John Schommer the evening of February 24th. Fred Payne was in charge of the arrangements, and a large number of Indianapolis men were present.

E. O. Griffenhagen, C.E. '06, senior partner of Griffenhagen and Associates, Management Engineers, tells us that his firm in recent years has been doing more and more work in the field of public administration and finance. During the year 1933 they have completed the installation of a system of financial administration in the state of Connecticut; completed an economy study of New York state government; finished the development of reorganization proposals for local government in Illinois; made an extensive inquiry into state and local government problems in Wyoming; finished a year's work for the state of Texas; and now have under way a comprehensive financial and reorganization project for the Commonwealth of Kentucky. This work, combined with services to numerous cities and countries, keeps Griffenhagen on the road a good part of the time.

Samuel L. Zimmerman, C.E. '08, now resides at 5312 W. Jackson Boulevard, and is engaged as Engineer for the West Chicago Park Commissioners. Sam now boasts of two sons, 14 and 19 years old, respectively. Give him a hand.

Blake Hooper, M.E. '07, is twice a grandfather. You couldn't blame Blake for this, but he is very happy about it just the same. He resides at 10911 Longwood Drive, Chicago.

Clarence U. Smith, M.E. '07, is chief engineer and general manager of the Milwaukee Harbor Commission. Letters addressed to the commission will always reach him. It is hard to believe it, but he possesses three daughters and two grandchildren. Tempes fugit, and Clarence isn't afraid of the "Big Bad Wolf".

C. O. Frary, '08, is located in the Peoples Gas Building, 122 S. Michigan Avenue, Chicago, and deals in household gas appliances and related equipment. Among his many connections is that of vice-president of the Bryant Heater Company of Cleveland, whom he represents in the Chicago territory.

J. T. "Corry" Walbridge, C.E. '07, is still in the general contracting business (believe it or not) and has been active in Mexico on big government work. His business address is 549 Washington Boulevard, Chicago.

Artie Jens, E.E. '04, has his own firm now, known as Jens, Murray & Co., in the Insurance Exchange Building, 175 W. Jackson Boulevard. They specialize in underwriting fire, casualty and industrial insurance. See Artie before you spill the kerosene.

Leroy Erricsson, E.E. '28, who was for so long an engineering sales representative of the General Electric Company for installing electric heating apparatus, is now a representative of the Dole Valve Co., 1923 Carroll Avenue, Chicago. Rumor has it that Erricsson's well-known heart of steel is gradually melting for a fair damsel who teaches out in Colorado. He may be a slow worker, but he is a good salesman, and supposedly we may be able to report his marriage soon.

Dan N. Stump, M.E. '13, is now teaching a class in Air Conditioning at the Western Society of Engineers, Chicago.

Alfred J. Danzinger, F.P.E. '26, met with serious injury at the Iowa Inspection Bureau on February 3rd. A scaffolding on which he was standing gave way, throwing him to the ground, breaking both arms, shaking, and bruising him considerably. His address is 1241 Hazel Drive Avenue, Cedar Rapids, Iowa.

Hen Clausen, C.E. '05, has been laid up for more than two months with a bad heart caused by over work and high blood pressure, but is back on the job now although still required to take things easy. He is treasurer of C. D. Osborn Glove Company, 2201 Wabansia Avenue, and very prominent in the National Association of Credit Men, of which he is a director. Henry's 'phone is Humboldt 1931. Give him a ring fellows, for old times' sake.

Billy Sims, E.E. '97, is now chief electrical engineer of the Commonwealth Edison Company of Chicago, 72 W. Adams Street, Chicago.

TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF AUTHORS AND PUBLISHERS

The Rohrbach Rotating Wing Airplane

(From Mechanical Engineering, February, 1934)

IN this plane, the usual fixed-wing system has been replaced by a rotating system consisting of three or more narrow chord wings of normal thick airfoil sections, braced by means of struts and tie rods to a revolving cantilever shaft. This shaft is continuous across the span and rotates in fully floating bearings carried in a fixed central casing built rigidly into the fuselage structure. The whole wing system is rotated through gears from an engine or engines carried in the nose of the fuselage, or in a separate nacelles over the fuselage. A free-wheel device or one-way clutch allows full auto-rotation of the wings in the event of engine failure, or when the engines are throttled below a predetermined speed. Lift is generated by suitably feathering or oscillating the wings throughout the cycle of revolution. This is accomplished by a control gear operating the wings through push-and-pull rods which positively and progressively change the angles of the wings (measured against the respective tangents of the cycle of revolution) to suit the practical operating conditions. The wings rotate in a forward direction at the top of the circle and at sufficiently high speed to develop useful lift around the lower part of the circle, and this useful lift is developed at practically every position around the circle of revolution.

Rolling moments are generated by means of a differential oscillation of the two wing sets, thus giving increased lift on one side and reduced lift on the other. Yawing moments are similarly produced by following the forward inclination of lift on the two wing sets, the yawing control being actuated by foot pedals. This is designed to give full control when hovering, since with no air to flow over the tail surface the usual rudder control would be inoperative.

Three wings are fitted to each rotor and revolve with a maximum speed of 420 rpm, corresponding to a peripheral speed of 260 ft. per sec. Flying performance with 2100 lb. all-up weight is given as 124 mph at full throttle; minimum speed at sea level, 0; backward speed at sea level, 19 mph.

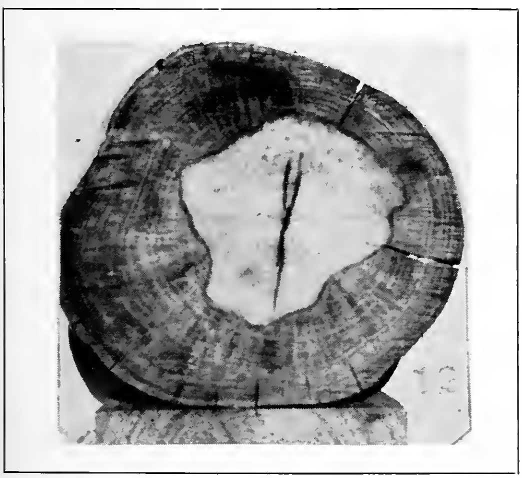
Penetrations Obtainable in Pine Poles

By C. M. Tilley, Superintendent, Texas Creosoting Co.
(From Telephone Engineer, January, 1934)

WOOD preservation is not as yet an exact science and the wood structure is infinitely complex. The wood is composed of millions of tiny cells of varying shapes and sizes, cemented together. Each cell is separated from its neighbor by walls of varying thickness and filled

with saps and resins which are developed during the growth of the tree. The cells of the heartwood are very resistant to the passage of liquid and also resistant to decay, while the sapwood is more easily penetrated and much more susceptible to the attack of the wood destroyers. The reason for this is that in the transition from sapwood to heartwood the cells die and become plugged with a froth like growth known as "tyloses", while the cell walls and in some cases the cell cavities, become infiltrated with various substances some of which darken the wood. This, naturally, makes the heartwood hard to penetrate and rot resisting to a high degree, while the sapwood with its live cells and pores is more easily penetrated and more readily attacked by the wood destroying fungi. Besides these factors, the proper seasoning of material before treatment has more bearing on the penetration obtainable than any other single factor.

Usually the heartwood gets little or no penetration when it is completely encased



Uneven heart growth with no untreated sapwood.

in sapwood. The oil may penetrate it for a sixteenth of an inch or a little more, but observations lead us to believe that this is the limit of heartwood penetrations in timber that is wholly encased in sapwood unless high final retentions are used. Heart faces without the sapwood encasement can usually be penetrated for from one-quarter to three-quarters of an inch, but penetrations of this type are encountered only in sawed timbers, as the heartwood in the usual pole is encased in sapwood except where it is cut off at the top and butt. The top and butt cuts are, however, taken care of very satisfactorily by the end preparations. The end penetrations go in from the end of the stick and travel parallel to the axis of the pole, and will extend from three to fourteen inches in depth, depending a good deal on the character of the wood.

Knots and pitch pockets, as a rule do not take oil readily, but as both are filled with pitch and are the most resistant parts of the wood, even when untreated, the shallow penetrations secured are ample to protect them against the small chance there is for decay in these sections.

Will Streamline Cars Hurt Motor Fuel Consumption

By J. B. Rathbun
(From Petroleum Age, January, 1934)

AFTER talking "streamlining" for years, several motor car manufacturers are bringing out really streamlined cars for 1934. There have been many wild reports current that this would reduce the consumption of gasoline greatly. Now if it were possible to make a perfectly streamlined car, which is far from being the

case, its resistance would be about 1/36 the resistance of the conventional 1932 automobile. At speeds above 40 miles per hour this would effect a distinct saving of power and fuel, and at 80 miles per hour the saving would be well worth the attempt. This is why airplanes, which fly at high speeds, put so much emphasis on design. The rate of increase of resistance is given by the well known "velocity squared law".

The average automobile, especially when driven in the city, doesn't travel fast enough to make either the expense or the inconvenience of streamlining worth while. "The inconvenience" refers to the inaccessibility of parts which the repairman will find where all of the mechanism is cooped up within the streamline casings, and where road clearance is reduced.

It would seem, after all these years, that the vagaries of the coil spring would be sufficiently well known to prohibit any more monkeying with the device; and the same thing is true of the proposed pantagraph spring suspensions with all of their monkey motions and susceptibility to wear. First of all, the coil or helical spring is the ideal agent for producing long continued vibrations and oscillations. For equal loadings, an uncontrolled helical spring will vibrate for full seconds where a leaf spring will kill the vibration in a small fraction of a second. A leaf spring is self damping because of the friction between the leaves, while a coil spring is not self damping. In order to bring a coil spring down to a state of normalcy when driving over rough roads means that this spring must be controlled, that is, must be coupled up with some external vibration damper that will take the "kick" out of the spring. This may be in the form of a friction controller or else some super-dash pot arrangement that will have many times the duty imposed upon it than the leaf spring places upon the present day shock absorber. It rather looks as if the shock absorber people were going to have some problems of their own.

Compressed Air in a Water Softening Plant

By R. E. Coughlin

(From Compressed Air Magazine, October, 1933)

CLEAN soft water is essential to the efficient operation of railroad locomotives. Solids carried in suspension or in solution quickly form deposits or incrustations which materially retard heat transfer and make it necessary to use more fuel to generate the required amount of steam. Continued use of such water soon renders the boiler incapable of attaining its rated output, and within a short time the locomotive must be taken from service while the deposit of scale is removed and dam-

Interior of Clinton, Ia., Plant of Chicago & North Western R. R.

age incidental to the use of unsuitable water repaired. Obviously, this is a costly and generally undesirable practice, and railroad systems go to considerable effort and expense to provide a suitable water supply at the many points where it is needed.

Because of the unsatisfactory condition of most natural available water, it must be treated before use. Though solids in suspension can be removed by mere filtration or allowing the water stand, mineral salts which impart hardness to water call for an exercise of different means. The removal of scale forming salts is effected by introducing definite amounts of chemicals that react with these salts, forming insoluble compounds which form no scale. Thorough diffusion of the chemicals is requisite to success and this calls for agitation of the water. Such agitation has conventionally been secured by mechanical means, but recently it has been found that compressed air is well suited for the task. Illustrative of its use in this connection is a new water-softening plant recently built at Clinton, Iowa, by the Chicago and North Western Railway Company.

The river water (Mississippi River water) at Clinton, as sampled over a period of twelve months, contains an average of 12 grains of incrusting solids per gallon, and varying amounts of river mud, and other suspended matter which at times exceeds 500 grains per gallon. Analyses show that, as a result of the treatment now being accorded it, the incrusting solids are reduced to less than one grain per gallon and suspended matter to less than two grains per gallon. The oxygen content of the treated water is the same as that of the untreated water. Agitation by compressed air has proved effective and a careful record of costs based on actual meter readings reveals that the cost of the air is at the rate of only one cent for every 15,000 gallons of water treated. Compared with the mechanical agitation this is very favorable.

In grains per gallon, the incrusting solids range as follows: carbonate of lime, 3.92 to 4.36; carbonate of magnesia, 2.1 to 3.42; sulfate of magnesia, 1.03 to 2.87; oxides of iron and aluminum, 0.02 to 3.09; silica, 0.07 to 0.25; alkali chlorides, 0.48 to 1.16; alkali sulfates, 0.29 to 3.28. After considering the composition of the water and studying the possible processes of treating it, a decision was made to install a complete water-softening plant in preference to a filteration system.

The cycle of operation is as follows: Raw river-water is pumped from an intake into the bottom of the inner tank at the rate of 120,000 gallons an hour. Lime and soda ash are introduced into the incoming water by means of a variable rate chemical tank. To assist the desired chemical reaction, some of the sludge precipitated from previous operations is pumped into the tank at the rate of 30 gpm.

Next the sodium aluminate is introduced into the tank by means of a National Type "P" dry feeder. Meanwhile the mixture is being agitated violently by the compressed air flowing into it at the tank bottom. This serves to promote the formation of large flocules of precipitate which are inclined to settle rapidly. After one hour's time, the mixed water and chemicals are discharged through an overflow line into

the outer tank. There the preciptate settles and is removed through perforated 4-inch radial piping at the bottom, terminating in quick opening valves. The clean, softened water is taken out of the top of the tank by means of a Snoco clean-water take-off which is connected to the pumps which transfer it to the storage tanks. The over-all time required to secure clean soft water is about three hours.

Beryllium Developments and the Outlook for Supply

By C. B. Sawyer of the Brush Beryllium Co.
(From Mining and Metallurgy, February, 1934)

DEVELOPMENTS respecting beryllium during the past year have been sufficient to center attention on it as likely to be the most important of any of the chemical elements that have recently found a place for themselves in technical industry. This importance is only potential, however, largely because adequate supplies of beryllium ore will be necessary. To find and develop large mines will be the problem.

Chief of the immediate commercial developments in the U. S. is beryllium-copper and its espousal by Anaconda and Riverside even at present high prices. According to the pamphlets of these companies, it appears that beryllium is to copper nearly what carbon is to iron. When 1.5% to 2.5% is added to pure copper, a heat-treatable alloy with a maximum tensile strength of 220,000 lb. per sq. in. or over is obtained; whereas copper has a tensile strength of about 33,000 lb. per sq. in. Striking among the properties of beryllium-copper is its resistance to fatigue, claimed to be equal or superior to that of spring steel.

Second of the commercial developments in the U. S. is the application of beryllium oxide as a refractory. When freed of alkalies and alkaline-earth impurities, this substance develops a melting point of 2570 deg. C., great strength, low density, extraordinary retention of electrical insulation properties at high temperatures, and extraordinary resistance to thermal shock.

Third of the developments affecting beryllium, though not yet in a comparable commercial form, is its use in metals other than copper, such as nickel and steel, as a precipitation hardening agent. This action seems to be general.

An announcement by the National Physical Laboratory, of England, states that beryllium, when pure, is ductile. Among its other properties are: a great resistance to corrosion, perhaps greater than that of aluminum; a Brinell hardness number of 60; a melting point of 1280 deg. C., which assures its retention of useful mechanical properties at high temperatures but retards its production by ordinary means; a modulus of elasticity about the same as that of iron; and a "lightness" about the same as that of magnesium. According to the National Physical Laboratory, it should have many of the mechanical properties of iron, without its weight.

Sodium Vapor Street Lights Set Precedent in America

(From Roads and Streets, January, 1934)

DISCOVERY of a glass which would withstand the deteriorating effects of the chemical reaction brought about by

glowing sodium vapor has allowed the design of a sodium vapor lamp that would serve as a practical light source. They have no filament, but a small amount of neon is used to conduct the current until the lamps become hot. These lamps have been under development since 1916 when Westinghouse received certain patents on their design. Up until this year, however, engineers have been handicapped by the lack of a suitable glass.

The first commercial street lighting installation of these lamps was recently dedicated along Park Avenue in Port Jervis, N. Y. Planned as a part of the unemployment relief program, the new street is city owned, including the ornamental standards and feeder circuits. Twenty-five Westinghouse sodium vapor lamps are spaced 125 feet apart along the outer edge of the roadway. Each of the lamps, which is nominally rated at 4,000 lumens, is enclosed in a heat-insulating vacuum cylinder resembling a thermos bottle, and in turn is surrounded by a Bi-lux Bowl refractor. Special Gillinger outer enclosing globes, 18 inches in diameter and consisting of light density, opalescent glass, complete the equipment. The lamps throw a soft, yellow light free from glare, all of which is used by the human eye for seeing. This makes them more efficient than the sun or than incandescent lamp in both of which much of the light is of no use to the eye. Drivers report that the illumination is much better than that from other street lights.

When in full operation, the power consumed per lamp is slightly under 100 watts. The overall efficiency of each lamp including transformer and secondary wiring, is in the neighborhood of 40 lumens per watt. This output efficiency is about twice that of the corresponding metallic filament lamp, a factor which constitutes one especial virtue of certain metallic vapor illuminants. The series circuit, supplying the Port Jervis installation, is part of a straight a. c. system now feeding other series Mazda filament lamps from a standard automatic tub transformer. The sodium vapor lamps have special Westinghouse transformers, mounted within the bases, which operate on a 6.6 amperes series primary circuit.

Some Recent Developments in Sewage Treatment Practice

By Wellington Donaldson

(From Municipal Sanitation, January, 1934)

THE dominant interest in sewage treatment at the present time seems to be along the line of chemical precipitation. The addition of lime alone to sewage in high doses, on the order of 1,500 to 2,500 pounds per million gallons, will usually produce excellent clarification with organic removal of about 65%. The addition of ferric salts in dosage of 200 to 400 pounds per million gallons alone or together with moderate dosage of lime is capable of producing good clarification and organic removal up to 70%. It seems to be a characteristic of iron salts to effect reduction out of proportion to visible clarification, and progressively with increase of iron dosage up to certain limits. If the settling stage of chemical precipitation is followed by filtration through inert material such as sand, the efficiency may be

pushed up to 75% or 80% for organic matter and 90% to 95% for suspended matter. By filtration through chemically reactive material such as zeolite it now appears that efficiencies equal to those from activated sludge, another biological oxidizing device, may be obtained.

There are now in use at Rockville Center, N. Y., vacuum filters for completing the clarification of an activated sludge plant effluent. These filters build up a thick mat of paper pulp through which the activated effluent is filtered. The mat is repulped and reused to form the filter medium until sufficiently charged with solids to become blinded. The dirty pulp is then dewatered on a separate vacuum filter unit and the cake is burned in the municipal garbage incinerator. The destruction of screenings by incineration is growing in popularity. Some thirty sewage plants are known to be equipped with special incinerators for this purpose, varying in capacity up to approximately three tons per hour. Many other installations are now being made or are under contract. Extension of the incineration idea to take care of all sewage solids is being studied carefully at Chicago and elsewhere but so far is not put into actual plant scale practice.

ENGINEERING PROGRESS

NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

New Recording Pyrometer

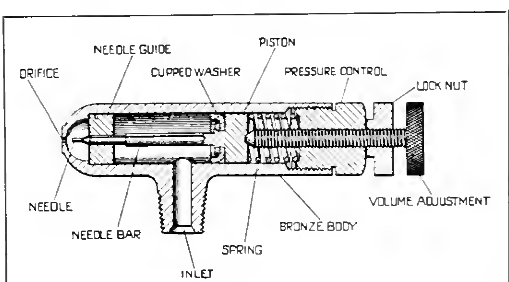
A NEW type of balancing mechanism is so designed that it produces a large movement of pen or print wheel for a small galvanometer deflection and it moves the printing mechanism quickly from one end of the scale to the other, without requiring rapid motion of the mechanism. The mechanism consists essentially of a V-shaped cam drive and a friction roller. The sensing fingers, which detect galvanometer deflections, position the friction roller according to the position of the galvanometer pointer. The V-shaped drive cam engages and rotates the rollers, which in turn transmits it in a straight-line motion to a slide-wire contact, moving it the corresponding distance. The pen or point wheel being mounted integrally with the slide-wire contact, moves with it, thus making the record coincide with the measurement. The record dots are square shaped, and each record is identified by a different color. Just below the upper chart roller, the chart passes under a scale of transparent unbreakable material with scale graduations on it. This makes the temperature values of the chart more easily read.

Adjustable Time Contactor

A NEW contactor which will operate in any position without the need of leveling and which is unaffected by vibration has just been introduced upon the market. Power for the unit is obtained from a reversing synchronous motor. The contact arm moves alternately clockwise within the time limit set, making a ten ampere, 110-volt alternating current load circuit for an adjustment at either extreme of its travel. Timing contactors of this new device also are available to be actuated from a momentary contact switch; these units run for the time cycle for which they have been adjusted and stop until the starting switch is again energized. The cycle stop contactors make and hold their load circuit at the expiration of the time set, or they may be supplied to make the load circuit at the start of the time cycle and break it when the time has elapsed.

Non-Clogging Spray System

A NEW spray nozzle has recently been developed. It is virtually clog-proof. The nozzle opening is kept clean and free of obstructing particles by a needle, which is automatically moved in or out of the orifice by the pressure of the fluid in

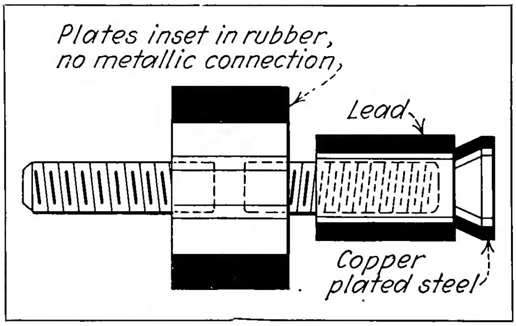


the line. As the fluid enters through the inlet, it exerts a pressure against the cupped washer in the front of the piston, which moves back to draw the needle out of the opening, allowing the fluid to discharge through the hole. When the flow is shut off, the spring forces the piston forward, replacing the needle in the orifice.

Pressure is regulated by adjusting the hexagonal pressure control nut, and the operating position of the needle, as adjusted by the knurled screw, regulates the discharge volume. A dock nut maintains this adjustment after the correct setting is made.

Sound Isolating Bolt

THIS new bolt is comprised of two elements, an anchor and a double stud with sound-isolating insert. The anchor is similar to the expansion bolt of the permanent type. The brass cone is dropped to the foot of a ¾ inch hole and a steel sleeve, with a lead exterior, then dropped over it and driven down by means of a special setting punch. The double-stud is then screwed into the interior threads in the steel sleeve. The bolt comprises two studs in plates joined by vulcanized rubber cylinder. Then there is no metallic contact between the stud ends. The machine is set on the insulating board around the sound stopper in the unit, and bolted to the top half. This puts the sound stopper in tension and provides sound isolating mounting.



Trap Design for Convection Heater

THESE traps were specially designed to fulfill requirements of concealed convection heaters. The thermostat of this trap is rolled phosphor-bronze especially designed for the service, and it is die formed in such a way as to distribute the movement and strain uniformly throughout the entire system. The cone type valve is of self centering design. The seat and the valve are both made of nitro-alloy and are extremely wear resisting. The body and cover of the trap are of heavy steam metal, and the ground joint is without a gasket. The nut is of malleable iron and the tail piece is of rod brass. The trap has ample capacity to discharge non-condensible gases and condensate quickly. These units, because of their small internal capacity, lower the heat output due to the retention of the non-condensible gases considerably.

Individual Radiator Valve

TO meet the requirements where completely automatic operation of radiator valves is not desirable, a valve has been improved by the valve in any position from full open to closed as with any hand valve. When set to operate in the automatic range, any room temperature from 60 deg. to 80 deg. will be maintained

without further attention, the valve automatically modulating to regulate the flow to exactly the right amount of steam required. All settings for both automatic operation and manual control are readily made with the lever on the top of the valve. When complete automatic operation of the heating equipment is undesirable or unsatisfactory this unit is excellent.

Steam Jet Refrigeration for Rockefeller Center

FOR air conditioning purposes in La Maison Francaise (French Building) Rockefeller Center has purchased a 300 ton steam jet refrigeration unit from the Westinghouse Electric and Manufacturing Company. This unit consists of a 72 inch diameter fabricated steel cold tank in which the water is cooled after circulating through the air conditioning system. Water is evaporated by high vacuum produced by four booster ejectors, two of which have approximately 20% total capacity each and the other two of which have approximately 30% capacity each.

These four boosters exhaust into a surface condenser into which they are imbedded from opposite ends in pairs. The condenser has a two-stage ejector with surface inter and after condensers mounted on the side. One of the 20% booster ejectors is automatically controlled to cut on and off responsive to the chilled water temperature leaving the unit within approximately plus or minus 1 degree F. of the base temperature for which the unit is designed. The remaining adjustment of load is accomplished by the manual control of the other 3 boosters.

Do you know?

That it takes jacks or better, to open a Pullman window.

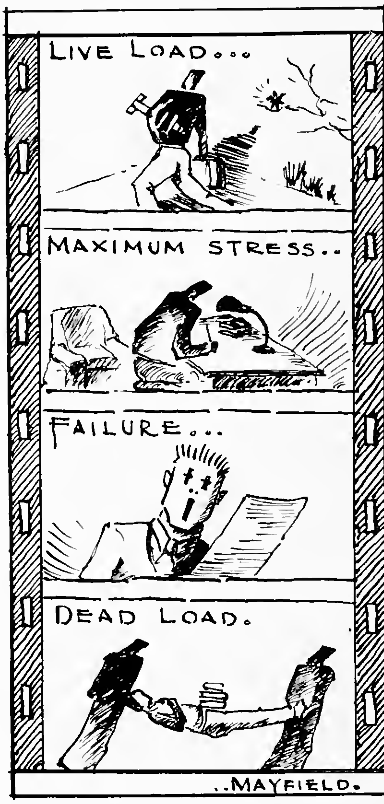
That war does not determine who is right—only who is left.

That social tact is making your company feel at home, even though you wish they were.

That the flu is both negative and affirmative. Sometimes the nose has it and sometimes the eyes.

That many a man who used to play golf to keep in the pink has given it up to keep out of the red.

That the sexes are no longer racing each other for supremacy; they have settled down to neck and neck. —*Neb. Blue Print.*



Prof.—What is one divided by nothing?

Frosh.—Infinity.

Prof.—Then what is two divided by nothing?

Frosh. (Blushing)—Infinite bliss, I guess.

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1. "What country is opposite us on the globe?"

2. "I don't know."

1. "If I were to bore a hole through the earth, where would I come out?"

2. "Out of the hole."

"Professor, I have you to thank for all I know."

"Don't mention it. It's nothing at all."

It is estimated that a man exercises a force of 100 lbs. per square inch when he hits the head of a nail, and 1,000,000 lbs. when he hits his thumb.

Butcher: "Shall I draw the chicken for you, Madam?"

Mrs. Newed: "No, thank you, your description is quite sufficient."

Conductor: "Madam, you will have to pay fare for this boy."

Madam: "But he is only 10."

Conductor: "Well, our rule is, long pants full fare, short pants half fare."

Colored Mammy (in rear of car): "Lawsee, next time I'se gwine ride for nothin'!"

Registrar: "You're a freshman, aren't you?"

Green: "No sir. I'm a Norwegian."

THE ARMOUR ENGINEER

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Night at the Steel Mills

Courtesy General Electric Company.

THE

ARMOUR ENGINEER

MAY, 1934

The Engineer and Social Science

By H. P. DUTTON

THERE are times in the life of every man when he is tempted to sit down and ask, "Is it all worth while?" The daily unremitting drudgery of the task, the remoteness and intangibility of the goal, lead to such moments of revolt. They come probably oftener than the average to the engineering undergraduate in the spring of the year. He is asked to take on faith, the efficacy of a discipline which he has not yet proven, and to work hard, in a world of books, of shadows, and unrealities. How his fingers sometimes itch for something tangible that he can grasp with his hands.

And this year the undergraduate at Armour finds he is confronted with an addition to his load, the new courses in Social Science. What have these to do with his career as an engineer?

The answer to that question, fortunately, is one which he can formulate himself with a little thought. The core and center of the engineer's training is a connection of the fact that events follow causes. If you subject a beam to a definite

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load, it will be deflected in accordance with definite laws. If you continue to increase the load, a time will come at which the beam will fail, and that load and time can be predicted within close limits for a given material. The same fixity of relationships exists, within close limits, in the prediction of the flux of a magnetic field, or of the reaction of the chemical elements. One comes to realize that wherever the speculations of the philosophers may lead us, in a practical sense we live in an orderly physical world. Events obey rules and if we know the laws we can control the events. In a very real sense, knowledge brings that sense and reality of power for which every man hungers.

That much is admitted. The process by which the callow high school graduate is slowly formed in the discipline of the trained engineer may at times involve strains and pressures, may bring its moments of unreasoning and revolt, but it is at least progress toward a goal recognized to be worth while. In the case of the man who lends himself with his whole heart to the forming process, it is accompanied by a steady growth of power and competence, in the mastery of the world of things, which is the normal result of the engineering training.

But of recent years a bleak and forbidding question has intruded itself on the comfort and assurance of the engineering student. Are there not too many engineers —more than the world needs or has room for? It is to men whose minds this doubt has penetrated that the new courses in Social Science should present the strongest appeal.

For we have begun to perceive that the method of the engineer need not be limited to the control of inanimate nature. The pattern which is woven by economic and social forces is a far more intricate, complex, and delicately sensitive pattern than that woven by the electrons which form the atom, but pattern and law are there none the less.

Frederic Taylor, father of "Scientific Management" was one of the first to prove to a skeptical world that the processes of business are susceptible to measurement and prediction. It took forty years for the idea to penetrate widely, but today the basic philosophy that Taylor taught is part of the technique of modern business. Many large and still successful businesses, along with a great host of small fry, still cling to the rule of thumb and tradition of their fathers, but among progressive and informed men the principles for which Taylor stood are no longer a matter of controversy. Even where the name of Taylor is unknown, measurement of work and costs, study of motion to bring them to the best known standards, teaching these best ways to the worker and awarding high pay for their mastering of them—the budget based on fact and known relationship between expense and output—these principles are today sweeping informed industrial practice, even though the great mass of the revolution is still to be accomplished.

It is an axiom of management, that as the art of measuring facts advances, the art of "bluff" recedes. The trend in business is notably toward measurement and planning and as this trend progresses, the

older type of business man, especially he who relied on "front" and speculative chances, is bound to find and *is* finding the going continually harder.

We begin to perceive, too, that the method of fact-finding and fact-using need not be limited even to business, broad though that field is and rich its opportunities. Government is a structure. When that structure is built by men who understand their human materials and are fortified by knowledge of how the bridge must be built to enable these materials to carry the load, then we can look for really sound and respectable municipal and state government generally. The violent criticisms properly leveled at many such governments today, and the very real abuses in some such governments, arise more often from wrong structure and lack of understanding than from any general depravity of government officials. It is a truism that a roof laid by a workman who does not know his trade is apt to leak. A defective delegation of power invites an abuse of power.

Here, then, is a field that should challenge the best brains of our generation. Government of some sort is unquestionably going to play a greater part in our lives in the future; that statement is not a matter of opinion or desire, but simply a logical corollary of the constantly greater intricacy and delicacy of the social and business relationships of our age. Unless civilization breaks down and reverts to a more primitive type, there are going to be important career possibilities for men of ability in seeing that government is good.

But one does not need to contemplate such new and unaccustomed activities and possibilities to see the practical value of mixing with one's knowledge of materials, some knowledge of the human world in which the engineers must live and work. It is estimated that about 80 per cent of the graduates of engineering colleges eventually land in jobs which are primarily administrative or selling rather than technical. How naive to concentrate all of one's attention on the technical issue and utterly ignore those things which, after all, in the case of most engineers, are going to be the main business of life.

Even the technical man is a meer helper's tool in the hands of better informed men, a sort of slide rule or calculating machine to be manipulated, unless he backs his technical knowledge of how to build the bridge by sound practical knowledge of how to find whether or not the bridge will justify itself after it is built—how much it will cost, and, if you will, what will be the traffic which will and must pay that cost.

The engineer, whether he likes it or not, must not only understand economics; he must understand selling. Outside of routine, people who will never do anything but take orders, my experience has firmly convinced me that some experience in selling ought to be part of the training of practically every engineer. Ideas are generally useless unless you can get other people to accept and believe in them. How many an engineer, sound in his theories, has seen his laborious studies and reports rejected because he lacked the experience and the confidence to build up in these other men, without whom the report was

a mere useless bit of paper, a clear understanding of his ideas and a living belief in their soundness.

Selling is also, when done with a sound ethical basis, a builder of character. One learns to take it on the chin and come back smiling. One learns to have the courage of his convictions, and to back those convictions with a fighting spirit that refuses to yield so long as it believes itself in the right. One learns to lead, to persuade and influence men.

Few projects of importance are easy to realize. Even though a man stands to benefit greatly by the sound proposal of the salesman, the first instinct is to resist change, and to fear it. The salesman learns to expect such resistance, and he learns how to deal with it. He learns something of the massiveness of events, of the slowness of their movements. He acquires something of the patience and rooted solidity of purpose which distinguish most of the doers in this world.

There is something, too, in the philosophy of the salesmen's average. One learns that nine attempts may come to naught, but that out of every ten door bells rung there will be one sale. One thereby acquires the courage to ring the first doorbell. After all, that is one of the great lessons in life.

It has been one of my duties during the hard, lean business years from which we seem now to be emerging, to talk with many unemployed men, probably two or three hundred in the aggregate, although I have not kept track. Many of these men have never before faced a situation when they were utterly on their own resources, utterly dependent on their own initiative.

The difference in men became impressive when one views them thus, comparatively and in an emergency. A fraction of them, I am convinced, can hardly be permanently stopped by an emergency short of death or utter physical incapacitation. These men have lost one job and gotten another, lost that and if need be invented another. No whirlpool of disaster has kept them down for long.

One of our youngest editors lost his job in the depths of the depression. Within two months' time he had canvassed his friends, had barely missed landing one important job, had had the refusal of another nearly but not quite as good, and had accepted a third.

I am afraid I am wandering from my subject. Social Science 401 and 402 does not automatically train engineers into sure fire salesmen. Nothing will do that but experience, ability, and determination. But we are among other objectives in these new courses, trying to open the student's eyes to the fact that there is something more than luck and blarney and high pressure in selling, that making a sale is a matter of technique, of measurement and satisfaction of needs, that it is in short, in its nature an engineering problem.

These courses in business and social organization are new at Armour, but a perception of the importance of a broader training is not new here. Since the foundation of the school there has been a recognition of the fact that an engineer was a man, and had a responsibility and a part to play in the world that was broader than that of the mere technician.

But perhaps, if my slight opportunities for observation qualify me to speak, there has been in part a failure on the part of the average student to realize how important these things would be to him in achieving his heart's desire, a position of merited power and responsibility in his community.

Too, these courses may in the past have been insufficiently integrated with the engineering "discipline." A student of law is formed, line upon line and precept upon precept, in a defined and dependable mould and habit of thought. You can tell how a lawyer's mind is going to work on any problem he faces. He is going to examine the evidence, weighing, casting out the color of emotion, testing truth. He is going to search the past for precedents, for guides to safe action. The lawyer has acquired a discipline, and it has proven on the whole a sound and eminently useful discipline.

Equally the engineer who achieves the purpose of his training is a disciplined man. It is not necessary, in the crowded four years of college life, that the student shall apply that discipline to every possible case, in business, and government, and who knows what else. It is enough that he has mastered it and is able to apply it.

Desirable though it is that the engineer know as much as may be about business, it is therefore not essential that he know all. He can learn later. But there is another purpose of education. It may seem to awaken the imagination to make the man aware of fields of which he might otherwise remain ignorant long.

I well recall a trip through a shop taken with my old master and teacher, Carl Barth. He told me to report to him, everything I saw that was wrong in the shop. A beginner, I found little to criticize. Then he went through with me again and pointed out a belt off center here, a disorderly work place here, improper lubrication in another place. From that time on many things to which I had been blind before, I saw.

So the new courses in the department may serve to open the eyes of the graduating engineer to many financial, economic, social, and other phases of his work of which he might otherwise have been unconscious for an indefinite period, and may thus serve to accelerate his orientation and progress in the business world.

An attempt has also been made in the new courses to show in many points specifically how the problems of business are susceptible to the analyses of the engineer and to convince him that no more in these fields than in the fields of mechanics or chemistry, may problems be met with vague generalization.

The point of view of the new courses, as has been said, is not new to Armour. In many straight engineering courses, instructors themselves possessed of an understanding of the engineering plus requirements of the business world, have introduced more or less formal instruction in one or another phase of economic and business analyses. It is not the purpose of the new courses to displace this instruction, but merely to amplify it and make it available systematically to all students.

The picture which perhaps most held the attention of the thousands last summer who visited the Century of Progress

exhibition of great art, a picture worth so much that it is almost literally beyond price, was not, as one would expect, of a vast world panorama, of a surpassingly beautiful queen or of a rare and incomparable jewel. It was of a subject common as earth, familiar and homely as people, the picture merely of an old woman.

But into that picture of his mother Whistler had put all that his imaginative mind had seen of the rare beauty of common things. Thousands before him had seen similar subjects. It took Whistler to see, and make apparent to the world, the loveliness and dignity and spiritual beauty of a serene acceptance of old age. Before one can see, he must be.

It is our hope at Armour that we may awaken the imagination of some, at least, of the men who pass through her doors, to the possibilities of service and of power that await the seeing and disciplined man. The world has far too many of the blind who must be led, far too few of leaders. It is my belief that the decades just before us are likely to see a flowering of the technical arts and particularly of the arts of organizing and leading people, which may make today look as primitive to our children as does the life and times of our fathers to us. Look at our archaic prisons. Look at our helplessness in the face of depressions. Look at our cities, those sprawling, unplanned, self-consuming blots on the countryside. Look at our homes, still imitating, in an age of steel, the stone columns which were themselves an imitation of the ancient Greeks of an earlier primitive use of wood.

Look at all these things and ask yourself whether the work of the world is done, whether the day of the trained and imaginative engineer is past. Look, and broaden your concepts, and dare to embrace the thought that some day you may play your part in shaping destiny. In the words of Daniel Burnham, make no little plans. Dare to open your eyes and see.

The day of the technical engineer is not past. There is reason to hope soon for a great revival of engineering activity as we start to clear away the accumulated obsolescence of the last five years. Much that was serviceable in 1929 is now obsolete and must be replaced. Changes in conditions and community needs, the natural force of growth and decay make the demand for the services of the technical engineer nominally a continuing demand. But it is my belief that in addition to these more familiar fields, wide new fields of activity and influence lie open to the engineer who views his profession imaginatively, and qualifies himself to apply his engineering discipline in economics and social as well as technical fields.

Accumulators for Peak-Loads

By F. M. GIBIAN

THE aim of this article is not to explain all of the technical details, but, rather, only those basic principles involved in the construction, operation, uses, and advantages of the accumulator.

The steam accumulator is nothing more than a tank which stores the heat energy of steam available at periods of low-load and releases this energy for peak-load demands. The heat is stored in water under high pressure and at the saturation temperature of the steam at this pressure and is released by allowing the water to flash into steam at a lower pressure.

The construction of the Ruth accumulator, as shown in figure 1, is comparatively simple. Its shell is built of steel plates and is cylindrical with the hemispherical ends. Due to the small ratio of exterior surface to volume, an insulation thickness of 3 to 4 inches is ample. The riveted seams are fitted with insulation blocks and may be removed for inspection of the seams. The accumulator is then encased with a thin weather-proof covering.

Water is fed into the accumulator until it is about 90 per cent filled. An overflow valve (OV), figure 2, on the high pressure line, opens when the pressure tends to rise, thereby letting the steam pass into the accumulator. The steam enters the accumulator through a non-return valve and is charged into the water through a group of nozzles. In changing from steam to water, the latent heat of the steam is given off; this tends to keep the water at the saturation temperature of the entering steam.

During periods of peak-load, the steam discharges through a second non-return valve into the same accumulator steam pipe

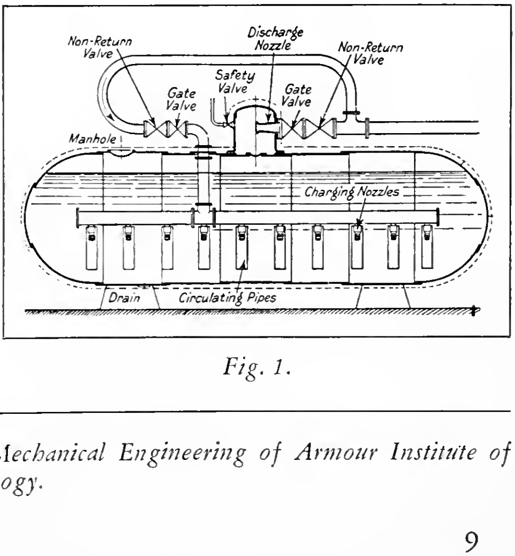

Fig. 1.

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and then into the low pressure line through a reducing valve (RV).

Since the valves are automatic in their operations, the accumulator requires little attention. For this reason, accumulators may be placed in any convenient place of sufficient size; often they are located outside of the building.

Most steam power plants operate for a fluctuating demand of steam. In short, there are periods, during the day, when the steam demand rate is considerably greater than the average rate; these are called peak-load periods. If a power plant had enough boiler capacity to carry the peak-load it would mean that the size of equipment necessary to furnish the difference between maximum load and that needed for average load may be considered the size of equipment for peak load. This is not true in all cases, but from the standpoint of original cost it is numerically correct. If the peak-load period is short, less than two or three hours, it is possible to substitute a steam accumulator for this peak-load equipment. In this case the power plant will be designed for average load.

Pressure and temperature of the steam, both in the pipes and boiler, are kept nearly constant; the fluctuations being confined to the accumulator. These conditions are desirable for several reasons. First, engines and turbines operate much more efficiently and reliably when supplied with steam of constant quality. Second, the specifications for process steam often require a comparatively narrow temperature range. Third, strains in the pipes and boiler tubes are reduced considerably by keeping the steam at constant conditions. The accumulator is built to withstand the fluctuations. Fourth, boiler efficiency is increased by reducing the sharp fluctuations in load. This, in turn, produces a corresponding saving in fuel. Fifth, another saving in fuel is realized by reducing fluctuations in temperature. With wide and frequent fluctuations in the temperature of the steam, the piping system also has many variations in temperatures. Each reheating of the boiler and pipes represents a loss in the heat of the steam and a consequent increase in fuel consumption.

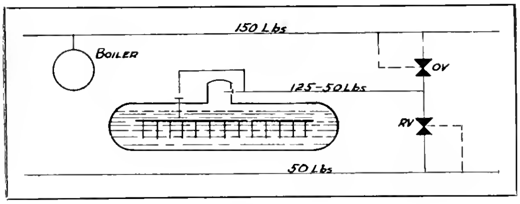


Fig. 2.

The discharge from accumulators may be consumed in three distinct ways: for process steam, for low-pressure turbines, and for boiler feedwater. The first two uses will be affected by floating the accumulator on the line, between the high and low pressure lines, in the manner already described; the use depending on whether the peak-load demand is for power or for process steam.

The third use, storage of hot water for feedwater, is present in detail in an article by Messrs. A. G. Christie and Warren Viessman[1]. The method of storing heat energy is accomplished in a rather unique

[1] *A. S. M. E. Transactions.*

manner. In contrast to the other two methods, mentioned previously, the stored water is not flashed into steam but is used for boiler feedwater. The heat is supplied by bleeding the turbine in four different stages, during periods of low-load. This bled steam is used in four feedwater heaters, connected in series to the feedwater line. During these low-load periods an excess of feedwater is used. This flows through an overflow valve, placed on the line after the last heater, and into the accumulator at high temperature. As the turbine load increases, the bleeder heaters cut out until peak-load, when all of the steam is used for the turbine. Consequently, the turbine output is increased to its maximum value. The hot water stored in the accumulator is now pumped into the boiler to prevent a drop in boiler output which would result if cold feedwater were used. The normal feedwater supply must be shut off; the heaters not being in operation at the peak-loads. Since most of this normal feedwater is condensate from the turbine, some means of storing it must be provided. This is accomplished by means of a surge tank which is emptied at the end of the peak-load, when the accumulator discharge valve is closed.

Simplicity in operation is one of the interesting advantages of this system. Only the accumulator discharge valve is manually operated. Since the pressure in the accumulator is greater than that of the normal feedwater, the latter is shut off by means of an automatic check valve. The steam for the bleeder heaters is also automatically regulated; since the temperature of the accumulator water is nearly that of the feedwater, after passing through the last stage, no load is placed on these heaters. Consequently, the steam is not bled from the turbine.

The installation cost can be as low as one-fourth that of an equivalent boiler installation. This, plus the simplicity and reliability of the accumulator, is the strong advantage in favor of this type of peak-load equipment.

The size of accumulators depends primarily on the pounds of steam required for the largest peak-load, and on the volume of water needed to produce one pound of steam for a given pressure differential. Figure (3) is a graph showing the pounds of steam liberated per cubic foot of water for various pressure ranges of water at the saturation temperature of steam at the initial accumulator pressure. If the pressure in the accumulator drops from 400 lb. gauge to 300 lb. gauge, it is seen that 1.8 lb. of steam will be liberated per cubic

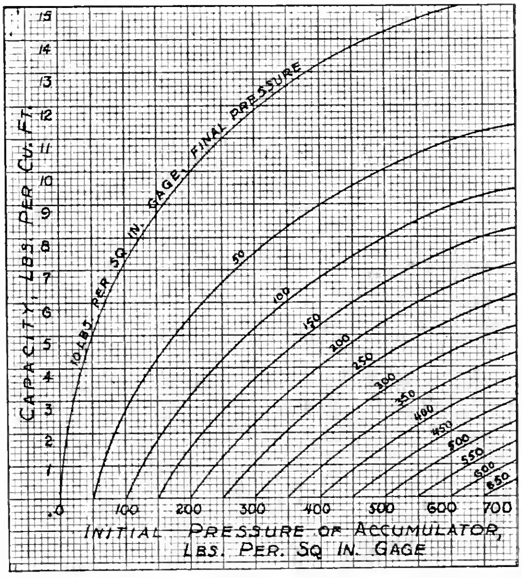
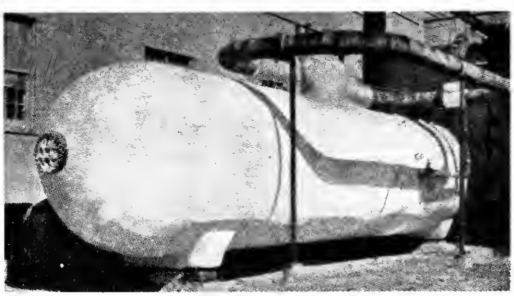


Fig. 3.

foot of water. However, if the pressure drops from 150 lb. gauge to 50 lb. gauge, an equal pressure range, 4.2 lbs. of steam per cubic foot of water will be liberated. This shows that, for equal pressure ranges, the steam capacity increases inversely as the initial pressure. Putting it in another way, the size of the accumulator is smaller for lower initial pressures, the pressure range and the excess steam demand remaining constant. Then, if the accumulator is 90 per cent filled with water, its size will equal the excess pounds of steam required for the maximum peak-load divided by 90 per cent of the pounds of steam liberated per cubic foot of water. Steam accumulators have been built from 200 cu. ft. up to 13,000 cu. ft. in size.

From a practical point of view, the omnipotent factor — cost — leads in importance. Cost can be divided into two sections: original investment plus installation charges; and operating expense. Since each steam power plant has a different peak-load demand for steam, no exact rule can be stated with regard to original investment, however, it can be shown that under certain conditions accumulators are less expensive than other types of equipment. It is also known that there are a great number of power plants operating under these conditions. Accumulators were installed in the Berlin City Electric Works at the cost of $45. per kilowatt. Their estimation on equivalent boiler installation was $60. per kilowatt. This shows the saving of 25 per cent of the original cost. These accumulators operated for a peak-load of three hours' duration. Assuming that the maximum demand is constant, it is seen that the size of the accumulator and its corresponding cost vary directly as the length of time of the peak-load. On the other hand, if this peak-load was carried by boilers, the boiler capacity would be equal to maximum peak-load and would be independent of the duration of the peak-load. In general it can be said that the greatest saving in initial cost of accumulator over boiler will be realized for peaks of high demand and short duration.



A Ruth Accumulator in Service.

Operating expense may be materially reduced, in some cases, by the use of accumulators. In the first place, accumulators, since they are automatic, do not increase the labor expense. An additional boiler, for peak-load, usually would require more men. This statement is more applicable to the larger power plants. Secondly, the increased efficiency of the boilers and of the entire system, due to the addition of accumulators, produces a reduction in fuel consumption and therefore a reduction in operating expense.

The advantages of accumulators may be summarized briefly as follows: Peak-load capacity is, of course, the outstanding benefit. Second, its reliability and automatism are also of major importance from a view point of practical engineering. Third, it

serves as a flexible link between supply and demand equipment and is also a flexible link for pressures and temperatures in the system. This ever-present supply of steam at constant conditions has shown an appreciable increase in production at industrial plants where the discharge from accumulators is used for process steam. Fourth, the elimination of sharp temperature and pressure fluctuations in the boiler and pipe system increases the boiler efficiency and also reduces physical strains in the equipment. Fifth, it can be installed in practically any convenient place including locations outside of the building. Last, but of great importance, the cost is comparatively low.

The accumulator is not applicable in all peak-load problems. It is an economical solution for many. The steam accumulator has been found to be of greatest service in plants where constant steam pressures and temperatures are required, and also in plants where the maximum load is considerably greater than the average load and the peak-load period is short.

Electron Tubes

By PROF. J. S. THOMPSON

THE term electron tube which is in current use includes a large number of devices whose field of application is rapidly increasing. In general, an electron tube consists of a glass or metal envelope which contains two or more electrodes; the envelope is gas tight and may be highly evacuated or may contain a gas or vapor under any degree of pressure. This arrangement may control, modify, or interrupt the supply of energy to its electrodes. The General Electric Company has adopted two general classifications: The Kenotron, which is any highly evacuated tube regardless of the number of electrodes, and the Phanotron, which includes all tubes containing a gas or vapor. Kenotrons are evacuated to a pressure of about 10^{-8} atmosphere and the operation of the tubes depends entirely on the motion of electrons which are supplied by some auxiliary source within the envelope. In Phanotrons a pure gas or vapor is admitted at pressures ranging from 10^{-6} atmosphere up to several centimeters of mercury pressure. In these tubes the electron current is augmented by the flow of positive ions formed in the gas or vapor.

Most of the electronic devices discussed in this article have only recently been graduated from the research laboratory but have nevertheless won a secure place in engineering and development work. The Westinghouse industrial tube handbook lists 105 different types of tubes while a recent compilation of all American tubes available contains no fewer than 350 with new developments reported almost weekly. The importance of the electron tube was amply demonstrated last summer at the Century of Progress Exposition where a large fraction of the scientific exhibits including the lighting ceremony and control depended directly on their use.

A considerable fraction of the electron tubes in use are of the Kenotron type. These include the various 2, 3, 4 and 5 electrode tubes used in radio for oscillators, detectors, amplifiers, and rectifiers. The present discussion will be limited to certain

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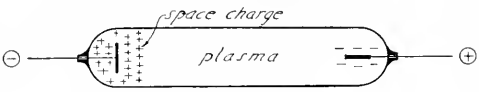
tubes of the Phanotron type and to the principles which explain their operation rather than to the various circuits in which they may be used.

Electrical currents of any considerable magnitude (i. e. greater than a few tenths of a microampere in most devices) flowing in a gas may be divided into two classifications: the glow and the arc discharge.

A typical example of the glow discharge is in the ordinary "Neon" type sign. The current passes between *cold* electrodes and is maintained by the processes occurring in the discharge itself—in other words, by the electrons and ions manufactured in the gas by the energy supplied to the tube. Before the voltage is applied, a very few electrons and ions will exist in the tube, their formation being due to radioactive material in the atmosphere and to the cosmic rays. With the voltage impressed on the electrodes, these charges acquire velocities producing a small corona current If this voltage is increased, a point is reached where there is a sudden rush of current or spark and the breakdown potential has been reached. This potential is about 20,000 volts for two needle point electrodes mounted one inch apart in air at atmospheric pressure. Each gas has its breakdown potential for given kinds of electrodes and spacing. Now if the atoms of gas are gradually removed from the tube the breakdown potential is lowered. This is because the electrons and ions can reach higher velocities as their density is decreased and finally can produce more ions and electrons by collision with the remaining neutral atoms or molecules. When this point is reached, the current increases rapidly with increased power to the tube and as this supply is increased, for example, by decreasing a series resistance in the circuit, the voltage now drops as the current increases and the discharge is said to have a negative characteristic. In the neon signs the pressure of the gas is of the order of several millimeters of mercury. A transformer giving an open circuit voltage of 15,000 volts is necessary to supply the breakdown potential for a tube about 40 feet in length. The transformer is so designed that after the glow starts the voltage drops to about 2000 for steady operation. Exact values depend on many variables the chief of which are: kind of gas, electrode material and shape, gas pressure, and tube dimensions.

The process of cumulative ionization referred to results in the characteristic colors produced in the tube when ions and electrons recombine to form neutral atoms. A dynamic equilibrium is set up in which the ions formed are balanced by ions recombining and those carrying the current. At the proper pressures the diffusion processes in the tube allow the glow to fill the space between the electrodes. All the various colors produced are the result of combinations of gases, type of glass tube, and relative pressures. To avoid chemical action with the electrodes those gases commonly used are the rare gases, Neon, Argon, Helium, and Mercury.

A characteristic of glow discharges is the large voltage drop in the neighborhood of the cathode or negative electrode. The reason for this is found in the large accumulation of positive ions in the neighborhood of the cathode which has the effect of mov-



• Current = .004 amp.
• Voltage = 1200.
• Gas press. = 0.17 mm.

FIG. I. — GLOW DISCHARGE TUBE.

• Current = 20 m.a.
• Voltage = 2000.
• Gas Press. = .05 m.m (approx.)

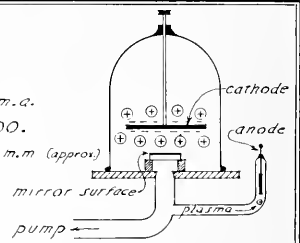


FIG. II. — SPUTTERING GL. DIS. TUBE.

• A-Cathode = 88 m.a.
• B-Cathode = 0.3 m.a.
• Area of A = 22 cm²
• Area of B = points
• Voltage = 80

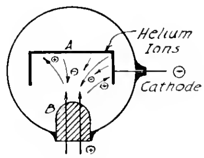


FIG. III. — RAYTHEON RECTIFIER.

• Westinghouse KI-605 •
• Max. current = 0.300 amp
• Voltage drop = 15
• Max. inverse volt. = 5000

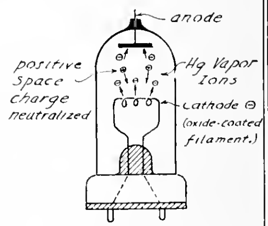


FIG. IV. — MERCURY VAPOR RECTIFIER.

General Electric Co.
• Current – 2-6 amp.
• Voltage drop = 15

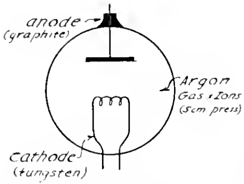


FIG. V. — TUNGAR RECTIFIER.

(cathode – not pool.)
• Temperature and pressure distribution
μ = 0.001 mm. of Hg.
(From: Morecroft's "Electron tubes")

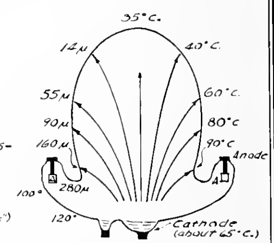
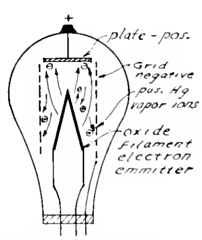
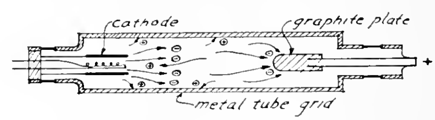


FIG. VI. — MERCURY ARC RECTIFIER.

(a.)
Type FG-17
• Plate current = 500 ma
• Grid current = 50 m.a
Voltage drop = 15

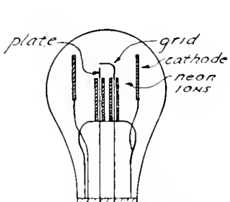




(b.)
• Metal thyratron – for large currents

FIG. VII — GENERAL ELEC. THYRATRONS.

(a.)
Cold cathode type
Westinghouse - K.U. 618
• Plate current = .015 amp
• Grid current = Small
• Voltage drop = 180



(b.)
Hot cathode type.
Westinghouse K.U. 610
• Plate current = 0.4 amp.
• Grid current = .0004 •
• Voltage drop = 22

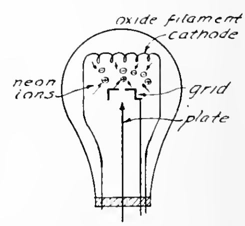


FIG. VIII. — GRID GLOW TUBES.

ing the positive electrode closer to the cathode. This layer of positives is called a space charge and it results from the heavy, sluggish, positive ions blocking their own passage when they attempt to converge upon the cathode. The process gives the tube its high effective resistance. A similar thing is going on at the anode, but the electrons being several thousand times lighter than the positives are more mobile and show much less tendency to accumulate. The middle portions of the arc consist mostly of a region of "plasma" which means that the number of positives and negatives are about equal and so the voltage drop per unit length is small.

Reference to Fig. I will show a simple diagram of a glow discharge tube using air as the gas. The data given for this tube as well as for most of the other tubes shown was taken in the Electronics laboratory at Armour.

Fig. II shows the arrangement used in a second application of the glow discharge commonly called "sputtering". This process is the electrostatic deposition of metals in a partial vacuum. The metal to be sputtered forms the cathode of the glow discharge and is shown mounted through the top of the bell jar envelope. The anode is shown mounted in the side tube. The material on which the coating is to be formed is blocked up on glass pillars as shown, in the path of the discharge. The distance, cathode to surface, is of the order of 2 inches. A 20,000 volt transformer supplies the power, and the tube accomplishes its own rectification as will be outlined in the next paragraph. The pressure is so adjusted that the outer edge of the Crookes' dark space is about one-half to two-thirds of the distance from cathode to surface. This means that the boundary of the positive space charge is approximately at this same distance and that there is a large cathode fall in potential in this region. The positive ions which leave the space charge region receive a large velocity due to this cathode drop in potential, strike the cathode, and produce intense local heating at the points of impact. Small particles of molecular dimensions are thus evaporated from the cathode and distill over onto the surface below. Here then, use is made of the cathode drop in glow discharges for producing uniform and controllable thicknesses in metal coatings. The Western Electric Company has installed a bank of sputtering units for forming gold coatings on the duralumin diaphragms of carbon broadcasting microphones. Here the cathode is of gold and the coating formed on the diaphragm surface has the advantage over chemical deposits in permanency, freedom from blisters, and uniformity. Other applications include the formation of metal coatings on instrument suspensions and the production of very thin films on glass and quartz for high resistance grid leaks. In our general physics laboratory, sputtered mirrors of gold and platinum are used in a number of optical instruments. With the unit described, an opaque film of platinum can be formed in about 2 hours. In general, the heavy metals sputter most readily and, in many tubes, the formation of the film on the walls is objectionable which explains the use of aluminum, graphite, and coated electrode surfaces.

Rectification of alternating currents has

been effectively accomplished in a number of glow tubes. Typical of these is the familiar Raytheon rectifier which is shown diagrammatically in Fig. III. This tube contains Helium gas at a pressure of about 20 mm. of mercury. The electrodes, B, are successively anode and cathode on alternating current, and their distance apart is so adjusted that for the potentials used the breakdown voltage is not reached between them. The data given shows a large current when the large electrode, A, is cathode and very small currents when the polarity is reversed. This is the type of rectification due to assymetric electrodes or the so-called "point to plane" principle. It is easily interpreted in terms of the space charge and cathode fall. When B is negative a blocking layer of positives easily forms about it due to its small dimensions so that for the voltage available little current flows. With A negative, currents flow to provide a space charge about the entire surface. This principle accounts for the self rectification of the sputtering unit described above as well as the gas X-ray tube and other glow discharges.

The arc discharge takes place between electrodes in a gas or vapor at much lower voltages. Usually the currents are greater than in the glow discharge but the volt-ampere characteristic is either zero or slightly negative. The essential feature of the arc is a cathode which can produce a copious supply of electrons usually generated from an incandescent tungsten filament or oxide-coated emitter — hence the designation, hot-cathode tube. These electrons pour out into the positive space charge and rapidly neutralize this blocking layer. As a result the resistance of the gas column is reduced and we deal with much smaller voltage drops. The current now is limited only by the external resistance and the ability of the tube electrodes to withstand the heat developed.

A simple arc tube is found in the Westinghouse mercury arc rectifier shown in Fig. IV. In this tube a few drops of pure mercury are introduced; as the filament current heats the tube the mercury is vaporized. The voltage input to the tube produces mercury ions throughout the interelectrode space. When the plate is positive the electrons from the filament swarm out and neutralize the space charge surrounding it and allow comparatively large currents to flow. However when the plate is negative no electrons leave the filament, very few ions are formed and the inverse current is small. As shown in the data there is only a 15 volt drop across the tube when current is flowing. This is only a little greater than the ionization potential of mercury, that, is, the potential required for an electron to ionize a mercury vapor atom. K. T. Compton, who with Langmuir is responsible for much of our information regarding arcs has defined the arc as follows: "A discharge of electricity between electrodes in a gas or vapor which has a negative volt ampere characteristic and a voltage drop at the cathode of the order of the minimum ionizing potential of the gas." Another type of mercury rectifier is shown in Fig VI. together with the vapor pressures and temperatures existing in various regions of the arc. Here the mercury pool forms the hot cathode and although its temperature is shown as only 65° C, pre-

sumably electron emission arises from intense local heating from the bombardment of positives. This unit is a half voltage full wave rectifier and is extensively used for charging batteries. Other rectifiers of this type are in use supplying large amounts of power. The Chicago-Brookdale sub station of the Commonwealth Edison Co. uses an installation of two Brown-Boveri arcs mounted in parallel delivering a peak load of 2000 amperes. The drop across the units is about 20 volts. This installation supplies 1500 volt direct current power to the Illinois Central Electric suburban lines. In these units the envelope is metal and an exhaust pump is constantly working on the line.

The Tungar rectifier is shown in Fig. V. This arc is formed in argon gas and its electron emitter is a tungsten filament heated to a temperature of about 2500° C. The whole unit is mounted in a bulb about the size of an incandescent lamp and finds a wide use as a battery charger.

Among the different Kenotron Types is the Pliotron or grid controlled tube. This tube, familiar to all radio workers, has reached the stage that makes us wish for something more. To quote from A. W. Hull of the General Electric Laboratories, "If only we had a tube which combines the control characteristics of the Pliotron with the low-resistance and large power capacity of the Phanotron." The desirable features of such a tube would be: Low resistance (similar to the arc); ability to start at will by the use of small control power; and ability to remain non-conducting after stopping. Such a tube has been developed. It is of the genus, Phanotron, and is named the Thyratron after the Greek word for door. A diagram of one of the smaller thyratrons is shown in Fig. VII (a). Electrons emitted from the oxide coated filament stream out into the mercury vapor under the influence of potentials applied to plate and grid. When these potentials bear the right relation to each other cumulative ionization sets in and the tube breaks down and passes current. A curve showing the control characteristic is given for one temperature in Fig. IX (a); below and to the left the tube is non-conducting, above and to the right represent the conditions for breakdown. Higher tube temperatures shift the curve to the left. After the tube has broken down the grid has no further control on the arc discharge; it controls *only* the starting. The reason for this again lies in the space charge. When the

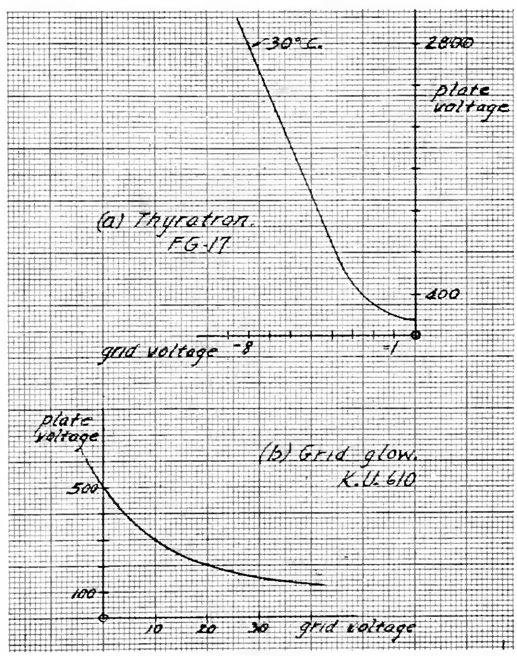


Fig. 9.
Characteristic Breakdown Curves.

arc is started there are about 10^{13} electrons per cubic centimeter in the current stream and an equal number of positive ions—10,000 times as many as exist in a comparable size Pliotron. Suppose then that under these conditions the grid attempts to influence the arc by becoming, say more negative. A relatively small number of positives will then leave the main discharge and cluster about the grid forming a space charge sheath, effectively reducing its potential to zero and leaving it powerless to produce any control. A similar situation will exist in the presence of a negative space charge if the grid is made positive. However, if the anode voltage is alternating the tube acts as a rectifier as described above and the arc is extinguished during the negative half of the cycle. It is during this period that the grid can regain control and many types of circuits have been devised for utilizing this function.

Thyratrons are capable of enormous power amplification, thousands of times greater than the Pliotron. A typical small radio tube Pliotron will give at best an increase of two milliamperes in plate current for a one volt change in grid potential—a Thyratron of the same size will give 2 amperes or one thousand times as much. Amplification of power may be as high as 10^{12} and the efficiency of operation may be as high as 99 per centum. Thyratrons are made in a wide variety of sizes and forms; Fig. VII (b) shows a type for handling larger amounts of power and in which the metal envelope forms the grid. One of the largest tubes available is of the mercury pool type having a continuous current rating of 5000 amperes at D. C. voltages up to 1500 and with an overload capacity of 14,400 amperes for one minute. These Thyratron rectifiers of alternating current are far superior to commutators on D. C. machines, not only in their freedom from moving parts and wear, but in their ability to control the magnitude of the current thus functioning as voltage regulator.

The Grid-Glow tube shown in Fig. VIII (b) is a Thyratron type containing Neon gas. Its grid-plate characteristic, Fig. IX (b), shows that the grid control is *positive* for anode voltages up to about 600. This is due to the placing of the grid directly over the plate forming a partial shield and requiring greater electron velocities for breakdown than in the thyratron shown above where the grid is outside. This tube has the advantage over the mercury type in shorter heating time and much less dependence on the temperature; it can be used only on inverse voltages of 1500 whereas the mercury type may be run to 2500. The type KU 618 shown in Fig. VIII (a) is really a grid controlled glow discharge and as such operates on higher voltages, about 440 being necessary for ordinary use. It is a supersensitive relay and rectifier particularly designed for low power control circuits.

Masonry Retaining Walls

By G. T. KORINK

"A RETAINING wall is defined to be a structure which sustains the lateral pressure of a mass which possesses some frictional stability in itself." These walls are used in Railroad work, Sewer work, Canal and Harbor construction, and Military engineering. The principles of design and construction are those of general application in structural design.

One of the most important considerations in the analysis of a given design or in the actual design itself is the consideration of the force exerted upon the wall by the retained fill. The points to be considered here are the magnitude of the force, its line of action, and its point of application. There are two theories that are outstanding in the evaluation and analysis of this force. Both are products of soil pressure analysis. The first of these is called Coulomb's Theory, or the maximum wedge theory. The working basis of this theory is that the resultant lateral pressure is assumed to make an angle with the normal to the wall varying from zero degrees to the angle of repose of the soil. Each new assumption of this angle leads to a different solution of the problem in hand; consequently for a given set of conditions we have an indefinite number of solutions, all of which have an "argument" in their favor. This is undesirable. The second of these two theories is known as Rankine's Theory. This seems to be the more acceptable of the two; it certainly is the simpler and more direct method of procedure. In Rankine's Theory the resultant lateral pressure is parallel to the surface plane of the fill providing, and this is an important consideration, the back of the wall is vertical and the surcharge is positive.

A digression here is in order, that a fuller meaning be placed into the remainder of the discussion. Assuming that P has been evaluated for magnitude, line of action, and point of application to the back of the wall, the analysis is one of simple statics. P is combined vectorally with the force vector representing the weight of the wall applied at its center of gravity acting downward, and the resultant, R, is pro-

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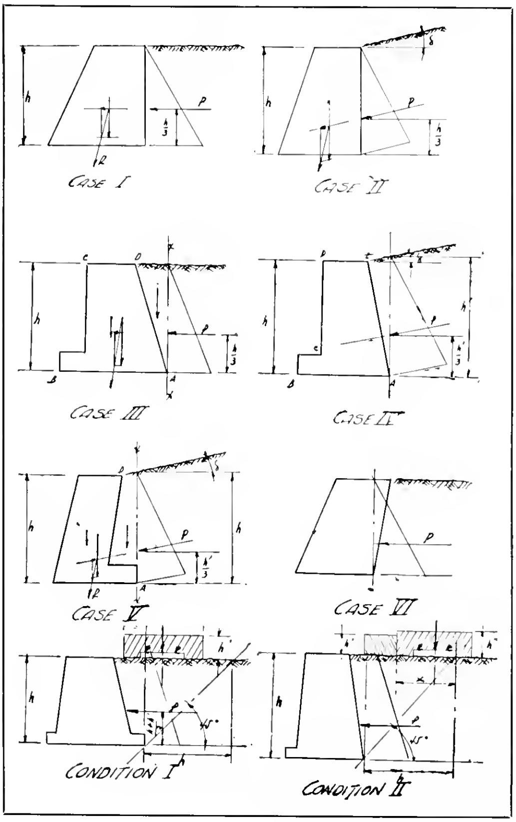
jected to pierce the plane of the base. It is preferable to have this point of intersection lie within the middle third of the base. However failure in this respect does not condemn the design. The stress at any point in the base, then, is $s = \frac{V}{A} \pm \frac{Vec}{I}$. If R intersects the line of the base outside the limits of the base, we have a condition of overturning. The horizontal component of R must be less than the frictional force developed at the base plane or sliding will result. Should R fall outside the middle third of the base there will exist a condition of zero stress on that side of the base adjacent to the fill, and the load is being carried by only a portion of the base. Since design safety is based upon an allowable



soil pressure, the utilization of only a portion of the base area in carrying the applied load results in an uneconomical design.

There are various conditions for which an evaluation of the lateral pressure might have to be made.

Case No. 1 is a vertical back wall with a horizontal fill. The line of action of P is parallel to the surface plane. The point of application is through the center of pressure of the force triangle.

A straight-line variation is used in soil analysis since all experimental data seems to indicate that granular masses behave like semi-fluids in transmission of pressure.

The magnitude of the force, P, is given by the equation: $p = \frac{1}{2}Wh^2 \frac{1 - \sin\phi}{1 + \sin\phi}$.

Case No. 2 is a vertical back wall with a positive sloping fill. The points to be noticed here are that the line of action of P is parallel to the surface plane, the point of application is still h/3. The magnitude of P is given by an empirical formula based upon the Rankine Theory in derivation:

$$p = \tfrac{1}{2}Wh^2\cos\delta \frac{\cos\delta - \sqrt{\cos^2\delta - \cos^2\phi}}{\cos\delta + \sqrt{\cos^2\delta - \cos^2\phi}}$$

The most general case is when $\phi = 8$, the angle of repose. With this condition the equation becomes $p = \frac{1}{2}Wh^2\cos\phi$.

Case No. 3 is similar to Case No. 2 with the exception of the earth fill above the heel. The condition is analyzed by passing plane x-x through the heel-point, A, and proceeding in the customary manner.

The magnitude of P is that of Case No. 1. The fill above the heel is handled in the same manner as the wall weight.

This method of passing a vertical plane through the heel-point is a general method

of procedure, and consequently a good point to remember.

Case No. 4. The distinguishing point in this analysis is the calculation of the magnitude of P. In this case we use h′ in the formula of case No. 1. The soil above the heel is again considered as wall weight, and the analysis from this point is as the general procedure.

A point to be remembered in the analysis of these walls with the projecting toes is the cantilever action at point C due to maximum soil pressure on the base of this section. Shear will undoubtedly be the controlling factor. A toe of sufficient depth to resist shear will resist the bending tension. Steel reinforcement is usually used at these sections.

Case No. 5 is handled exactly as Case No. 4 if the head-point, D, does not extend back of the plane x-x, passed through the heel point, A. Should the point D come behind the plane x-x, the analysis becomes a more-or-less difficult procedure. The problem is handled by a graphic analysis known as the "ellipse of stress." The analysis is too intricate to attempt here. It is a method that would be taken from an authoritative text should occasion of its application arise. Walls with backs sloping toward the fill are very seldom seen in practice, due to the very good reason that frost action causes them to heave outward.

Case No. 6 is a special case of Case No. 5. With a horizontal fill as shown the analysis is identical to that of Case No. 1, even though point D extends back into the fill some distance past point A. This application is illustrated merely to mention the exception to the type case of No. 5.

Consider now the case of "Loaded Surcharges." The method of handling this analysis is to substitute an equivalent earth fill for the direct load. There are three conditions of load on a fill which must be considered.

Condition No. 1 is where the width of equivalent fill lies entirely in front of a plane passed through the fill at a distance equal to the height of the wall, h, measured from the heel of the wall back into the fill and through the heel-point of the wall. The most common case encountered is that of a railroad or highway contributing the load. In this instance the width of equivalent fill is taken as 14′. Should the c.-c. distance be less than 14′ for a two way traffic lane, the c.-c. distance is used as the width of equivalent fill. The height of the equivalent fill, h′, will equal the applied load per longitudinal foot of wall divided by the weight of 14 Cu. Ft. of fill. The magnitude of the lateral force will be the same as that of Case No. 1 where h will equal $(h + h')$. The line of action will be through the center of pressure of the force trapezoid.

Condition No. 2 is that in which the plane intersects the width of equivalent earth fill. In this case the load effective on the wall is obviously less than that in Condition No. 1. Empirical derivation shows that the height, h′, to be used in this case is equal to (x/h) (h'') where h′′ is the true height of equivalent fill calculated from the applied load divided by the weight of earth fill for unit depth. x in this ratio is the distance shown in the figure.

Condition No. 3 is that in which the en-

tire width of earth fill lies beyond the plane, and in this case the effect of an applied surcharge is considered zero.

Any kind of a column load or a load contributed by a building structure would be handled in the same manner. In the case of a column load, the width of bearing of the column base would correspond to the 14′ width. With a structure of any size, the foundation would, no doubt, be sunk to a greater depth than the height of the wall and consequently would not be considered.

In the solution of a given problem any number of recommended methods of attack may be followed,—use of empirical data, data tables, procedure based upon personal experience, etc. The method that appealed most to the writer was that suggested by Professor Baker of the University of Illinois Graduate School. He suggested the use of intelligent guesswork and the application of the fundamentals of statics. For a given job, investigate the soil. If it is a loose granular soil such as sand use ϕ equal to an angle of 1½-1; for a more rigid soil use a repose slope of 1-1. Obtain the weight of the soil per cubic foot, and then starting with a top width of 0.3 or 0.4 of the required height and working with a face batter of 1″ or 2″ per foot of height design for economy of cross-section, stability, and a factor of safety of two. In designing this most economical cross-section, it is well to keep the following facts in mind:

1. Sliding depends upon weight only and not upon the shape of the cross section.
2. Crushing depends upon the relative position of the pressure center and the center of the base. It is a fact that safety in crushing varies as the stability of rotation.
3. For a given amount of masonry, the longer the moment arm, the greater rotation stability.

The above makes the design a common-sense procedure which is always the safest procedure in handling a problem the solution of which depends upon theory which is more or less conjecture.

One of the very important features in the construction of a wall (in fact the most important from the Engineer's viewpoint) is the drainage of the fill. A soaked fill weighs more and has a smaller angle of repose. Both of these factors contribute to multiply the magnitude of the lateral force. Since the wall is originally designed to resist a certain definite lateral pressure, any positive increase in this pressure encourages failure and should consequently be avoided if possible. The drainage of the fill is usually cared for by placing what are called "weepers" in the wall. These weepers are small holes about 4″ in diameter and spaced 15′ or 20′ apart longitudinally. They slope from the fill toward the face of the wall and are usually connected with some sort of a longitudinal drain to carry the water to them. Many times a layer of sand and gravel, or some other such porous mixture, is placed next to the wall to facilitate drainage to the longitudinal connection of the weepers. The principal concern is to get the water from the back of the wall where it is a major hazard to the face of the wall where it becomes a minor consideration.

Another point to be given thought in the construction of a wall is the foundation. A feature in connection with foundation work is to always place the base of the foundation below the frost line, to prevent

heaving by expansion during cold weather. Of course for a wall of any appreciable size, the foundation will always be placed 3′ to 4′ below ground level which for most localities is below the frost line so that this ceases to be of any great importance. Should the wall heave a bit it is obvious that it will again settle with the thaw and, except in the case of very light walls, no damage will have been done. A very light wall would undoubtedly present unsightly cracks under even slight heaving. There is one other feature in foundation work and that is the condition where the soil bearing values are such that they must be exceeded. The usual combat of this is to place the foundation on a system of pile network designed, preferably, to take the total load.

These walls are often of some little length running for distances of a mile or so. Such walls must be built in sections. The customary length of these sections is 30′ to 40′. There is a rule, originating from practice only, that the length of these sections never exceed twice the height of the wall. The vertical and horizontal alignment of these sections is maintained by embedded steel bars at jointing points. These bars are fastened rigidly in one section and slide loosely in the adjoining section. The loose sliding part of the connection serves as a contracting correction. Inasmuch as non-reinforced concrete design is calculated to take zero tension, contraction in a wall of any length is an important consideration. Expansion is of no concern since concrete is a compression material. The joints on the face side are V shaped grooves ¼″ wide formed with sheet metal. On the back face the joints are water-proofed by 4 or 5 layers of burlap and coal tar pitch. If the fill is continuously damp, this water proofing is placed over the entire rear surface of the wall.

There is a point in connection with construction detail that is seldom taken advantage of. With regard to the dumping of the fill behind the wall. There is a so-called "plane of rupture" when earth yields in a lateral direction. If the fill is dumped toward the wall, these planes of rupture tend to become pre-cast in the direction of the wall due to the nature of the earth to settle itself in layers. Any disturbance of the vicinity causes an immense pressure to be immediately transferred to the back of the wall because of the preformed planes of rupture. The fill should therefore be dumped away from the back of the wall so that these rupture planes tend to become pre-cast in a direction away from the back surface of the structure. This characteristic feature of soil behavior then becomes a factor of safety since these planes must now first be broken down before any increase in lateral pressure reaches the wall.

NOMENCLATURE

V = vertical component of the resultant force acting upon the wall.
A = area of base.
e = eccentricity of the point of intersection of R and the base line, measured from the gravity axis of the base.
c = distance from the gravity axis of the base to the point where the stress is desired.
I = Moment of Inertia of the base area about its gravity axis.
R = resultant of all external forces acting on the structure.
P = lateral force acting on the wall due to the retained fill.
w = weight per cubic foot of the fill material.
δ = angle of surface slope of the retained fill.
ϕ = angle of natural repose of the fill material.

Standpipe Protection for Tall Buildings

By G. W. WHEATON

A STANDPIPE and hose system furnishes a means of invaluable fire protection in tall buildings, where, because of the high cost of appearance, a sprinkler system is not practical, or where it supplements a sprinkler protection. Briefly, such a system consists of a vertical pipe, adequately supplied with water, to which hoses may be attached on each floor for fire-fighting purposes. The standpipe furnishes the only reliable means of obtaining effective fire streams at the upper stories of high structures and of furnishing such streams in the shortest space of time. The pressure necessary to force water to the upper floors of our modern skyscrapers will break the ordinary fire department hose, and the carrying of hose into a tall burning building is a slow and dangerous task. Therefore, the ordinances and building codes of many of the large cities require standpipe installations in buildings over eight stories high, and their use is nearly universal in most of the larger office buildings, department stores, hotels, et cetera.

The standpipe system furnishes two types of fire protection, that of first-aid protection and that of public protection by the city fire department. There are, therefore, three classes of service for which the system may be designed:

(1) For use by occupants as a piece of first-aid equipment in fighting incipient fires.

(2) For use by fire departments and those especially trained in the handling of heavy fire streams as required for the more advanced stages of a fire or an exposure fire.

(3) For use by both the fire department and occupants.

Of these three classes the third is probably the most generally preferred. Statistics kept by the New York City Fire Department for a five-year period show that out of the 753 cases in which standpipes were called into action in that city, 400 were handled by occupants alone, 324 by fire departments alone, and 29 by occupants and fire departments jointly. Of these cases 572, or 76 per cent, were taken

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G. W. Wheaton, a junior in Fire Protection Engineering, is a member of Salamander, Tau Beta Pi, and Sphinx.

care of by one line only. This indicates that the best method is to provide a standpipe suitable for use as both private and public fire protection equipment.

The size of the standpipe needed for such a system should be not less than 4 inches in diameter for buildings less than seven stories in height, 6 inches for those less than twenty-one stories, and 8 inches for those over twenty stories. These are the minimum requirements but are in general conformity with the city building codes.

In the majority of cases, the number of standpipes or risers needed in a particular building depends on the area and should be such that all parts of the buildings are within 30 feet of nozzles attached to 2½ inch hoses not longer than 100 feet. For the first-aid feature of the protection it is necessary that all parts of each floor be within 20 feet of the nozzles of first-aid hoses not longer than 75 feet. To accomplish this it is sometimes necessary to have additional smaller standpipes or horizontal branches for the first-aid streams.

Standpipes should always be placed as near as possible to or in staircase towers so that a playpipe or nozzle can be held to the last moment before the fire forces the floor to be cleared. One riser may be made to do duty for two adjoining buildings or compartments by placing it in the dividing wall with hose outlets on each side. Where a building is exposed within 75 feet, standpipes should be located so as to afford exterior as well as interior protection.

The piping and fittings are preferably flanged, of wrought iron or steel of standard quality, and strong enough to endure pressure necessary to force adequate streams of water through it to the roof. Offsets and bends should be avoided, and if a bend is used, its radius should be five times the diameter of the pipe. The standpipe should rest on a brick pier foundation and be rigidly supported by a sufficient number of hangers or braces to withstand vibrations due to water flow. Cross pipes should connect risers in the basement, where several are used. Horizontal feed lines should be hung from floor beams by heavy iron hangers. Approved expansion joints should be provided where necessary.

In order that the standpipe and hose system be effective in fighting fires, a supply of water, adequate both in pressure and volume must be available. For the use of the system by the fire department, the water is usually pumped into the system through connections on the outside of the building, but for first-aid service a ready high pressure source must be available.

A public water supply taken from the city mains is considered the best means of getting water immediately in undiminishing volumes, but in cities on the Great Lakes the low service pressure is only good for several stories and other means must be resorted to. These are, in order of their relative value: automatic fire pumps, manually controlled fire pumps with pressure tanks, pressure tanks, and gravity tanks. There should be two independent sources, the first, one of the two types of tanks, giving immediately the required pressure for the first-aid outlets, until the second source, such as a fire pump, good for a long period, is brought into action for use

in sustaining the flow through the first-aid hose or aiding the fire department pumpers when the larger hose is used.

The minimum supply to each riser should be 250 G.P.M. with a pressure of 50 pounds at the highest 2½ inch outlet, to insure adequate pressure and volume to throw water across the areas to be protected. The minimum sizes of sources of supply should be: for approved fire pumps, 500 G.P.M.; pressure tanks, 4,500 gallons; and gravity tanks, located on the roof, 5,000 gallons, with bottom elevated 40 feet above the highest hose outlet. If domestic supplies are drawn from the same gravity tank, there should still be 5,000 gallons below the lowest service pipe. All water tanks should be supported by iron beams resting on masonry walls so arranged that they hold their places to the last. Tanks supported by wood beams are dangerous because, in falling quickly when exposed to fire, they wreck building, peril firemen, and disable standpipe system. Water tanks should be examined carefully as the danger of rusted hoops on the point of failure and water below the indicator or frozen are serious matters at time of fire. Pressure tanks are best located in basements. It is desirable that the pump and engine room be cut off from the rest of the building so as not to be flooded by discharged water.

Connections from tanks should be at the top of the riser except where there are several risers, in which case they should be made at the base as should fire pumps and outside connections. These connections should be of the same diameter as the riser. The fire department connection should be to the outside of the building ending in a two way 3 inch fire department siamese connection or a 4 way double siamese connection in larger standpipes, with approved clapper valves and caps. This connection should be 2 to 3 feet above the sidewalk where it can easily be seen by the fire department. Signs should be placed on the standpipe connection to distinguish it from the sprinkler connection. It cannot be emphasized strongly enough that the couplings on these siamese connections should be standard or the same as the local city fire department uses so that no trouble is experienced in connecting pumper lines to the standpipe.

Check valves should be provided in the connections close to each water supply and properly pointed. They serve the important function of preventing flow from taking place into one source due to a greater pressure furnished by another source. The flow is thus kept confined to the standpipes and hose rather than going towards filling up an empty gravity tank. Each inlet of the siamese connection should have its own check valve besides the other check valve in the main connection to the riser, placed inside the building to prevent the water from backing out into the street when not in use and to prevent freezing. The pipe between the check valve and the outside hose connections should be so arranged as to drain automatically by means of a drip valve or the like. Gate valves should be provided at each source of supply except the fire department connections where they are prohibited. The underground connection from a city main to the riser is best provided with a post indicator valve. Pressure gauges should be supplied.

In the standpipe system for first-aid and public protection there are two outlets constituting a hose station from each riser at each floor, one for the first-aid hose connection and the larger for the larger hose connection. Hose stations should be conspicuously located within 6 feet of the floor and unobstructed. It is essential that all equipment be in good working order at all times, for it is this apparatus that furnishes the direct means of fighting the fire.

On the first-aid outlet is mounted the smaller hose for use by occupants of the building in fighting incipient fires. This hose should be 50 to 75 feet in length, of a 1½ inch diameter and provided with a ½ inch nozzle. Unlined linen hose is recommended for such installation for in a heated building, cotton rubber lined hose, as used by fire departments in their daily use becomes brittle with age and heat. Linen hose must be kept dry and seldom tested for wetting promotes weakening of the fibers. The linen hose, though it usually leaks like a sieve when first wetted, gradually swells up and serves its purpose well. The first-aid hose is mounted in folds in a semi-automatic rack on which is a sign reading "Fire Hose for Use of Occupants of the Building." The semi-automatic rack is so designed that one man can handle the hose. He can open the hose gate valve, and not until he has pulled off the last fold of hose will water flow, by which time he will have the nozzle in full control.

The connection for the larger hose should be provided with not more than 100 feet of 2½ inch unlined linen hose with 1⅛ inch nozzle tip, mounted in folds on a non-automatic rack bearing the reading "For Fire Department Use Only—Dangerous." Whether this keeps occupants from attempting to use hose or not, it does free the building owner from liability in case an offender gets hurt or killed in trying to handle the powerful stream by himself. The operation of this hose requires two men, one to lay out the hose and hold the nozzle or playpipe firmly while the other turns on the valve. It is best to have two men holding the playpipe.

The argument that often comes up is whether or not the hose should be provided for the fire department. In many cases when an attempt is made to use such a furnished hose, it is found very unsatisfactory and inferior, with couplings missing. However, in probably as many instances it has been found quite all right for quick use by the first arrivals from the fire department,who can be already playing it on the fire before their company men have time to arrive with their 50 feet lengths of cotton rubber lined hose to take its place. Former Chief Kenlon of the New York City Fire Department believes that for this reason its presence is justified. It is also possible that a building will have its own organized crew of employees quite capable of handling the larger streams. Building owners should check up on this equipment frequently and see that hose and couplings are standard so that this larger size hose is given the proper appreciation.

Hose racks should be of good construction with free movement of parts. The hose should be easily removed with a slight jerk to remove the holding pin and without catching in the rack or tangling. The rack should be capable of swinging 150° if not

in a cabinet and 90° if in a cabinet so that the user of the hose can run out in most any direction. Either cabinets or covers should be provided to keep the hose clean from dirt and burning cigarettes, free from industrial vapors, or protected from mischief makers.

Hose valves should be provided at each outlet of either the gate or angle type, to which the hose is coupled. For the 2½ inch hose National Standard Threads should be used or those threads adopted by the municipal fire department. This is important so that in case the fire department brings their own hose, they will experience no difficulty in attaching it. The hose valve should be provided with a suitable open drip connection so installed that any slight leakage past the valve seat will be carried off and prevented from entering into the fire hose, which should be kept as dry as possible to prevent its rapid deterioration.

In a building of any height there is a great variation in pressure in the standpipe outlets at the upper floor and at the bottom. In fact, the pressure at the bottom gets so exceedingly large that it might easily burst an ordinary unlined hose if admitted directly to the hose. The insertion of a restriction orifice in the hose valve or coupling is therefore required where the pressure at the outlets is over 50 pounds during flow. This device is called a pressure reducer and is a fitting intended to reduce existing high pressures in a piping system to such a degree at the hose nozzle that the hose can be managed by persons untrained in handling heavy streams which might issue from even the smaller first-aid hose at extremely high pressures. As this device can be adjusted to give any desired low pressure it can be used where no smaller hose is provided for first-aid use. With the arrival of the fire department the pressure reducer can be opened to any desired pressure by merely turning a sealed nut, and a greater pressure is thus produced. For instance, it can be used to reduce a pressure of 192 pounds to 15 pounds at the nozzle entrance of a 2½ inch hose provided with a 1 inch tip when the reducer is just slightly open. This gives a stream which a person with little knowledge of holding a hose could handle, and a turn of the controlling nut would give a pressure of about 30 pounds, as desired by the fire department.

Standpipe and hose protection for exceedingly tall buildings, or skyscrapers, requires a special treatment. Instead of providing but one system for the whole building, there may be two, three, or even four separate systems, each for a group of floors and having its own separate supply tank and pump. These systems may be entirely independent if only a first-aid system is in use, but when fire department service is desired, they must be supplied by at least one riser from the ground level for the fire department connections.

A brief description of the standpipe equipment of the Woolworth Building in New York City will suffice to illustrate how skyscrapers may be protected. In this 55-story building, which is 750 feet high, there are six 6 inch risers running from the sub-basement to the 30th floor. Because of less floor area above this point, only two of these continue from the 31st to the 41st floor, one of which continues on up to the

55th floor. The standpipes are connected with steel storage tanks of a total capacity of about 30,500 gallons at five different levels, namely, the 53rd, 50th, 37th, 27th, and 14th stories. Swinging check valves are so arranged that each tank will be able to maintain its own pressure on the portions of all standpipes below it down to a level of one story below the next lowest tank. One electric and five steam pumps, supplied from street mains, replenish these tanks. These also can take water from two large suction tanks and a swimming pool in the sub-basement. Water can be pumped through three siamese connections at the ground level by fire department pumpers. The check valves are so arranged that pressure built up in the standpipes from below by the fire pump or by the fire engines delivering through the siamese connections will close the communication between the standpipes and the open storage tanks.

The pipe and fittings for the system are extra heavy malleable iron tested at the factory for 2000 pounds and periodically tested at the installation for 400 pounds, a safe value for the 850 feet maximum head needed to supply the highest hose lines. 75 feet of 2½ inch labeled linen hose with standard 1 inch nozzles is mounted in swinging racks at each hose station and each outlet is supplied with an extra strong gate valve and pressure reducer. Thus this system has furnished effective protection for this extraordinary structure for the last 20 years with but minor losses.

Since buildings in process of construction, which are over 100 feet in height, are serious fire hazards and offer a very difficult problem to the fire department at the higher levels, most building codes require that temporary standpipes be installed as the construction progresses. They should be in such condition as to be available for use by the fire department to the uppermost floor that has been completed. In all cases the temporary as well as the permanent equipment should be built according to plans corrected and approved by the local building authorities and the fire insurance rating bureau engineers. The "Regulations of the National Board of Fire Underwriters for the Installation of Standpipe and Hose Systems" should be strictly adhered to.

The minimum requirements for the standpipe at any time are as follows: the pipe should be of proper size and strength, securely and adequately supported at each floor; two siamese connections should be provided at the ground level, which shall be readily and easily accessible to the fire department at all times, with guards to prevent injury; at each floor level, to within a floor of the highest forms, should be two standard hose valves for fire department hose, properly protected; the standpipe should be carried up with each floor and securely capped at the top, to prevent dirt and building materials falling into the pipe and obstructing it and to prevent water from flowing out at the top when pressure is desired at a hose outlet in case of fire; a length of hose, nozzle, and wrenches, in a metal box should be provided at the highest outlet; there should be a good hoist or elevator and a watchman on duty at all times who is well acquainted with its use and the layout of

the building; and it is desirable to have a telephone system to the ground. This temporary standpipe should be kept in service until the permanent installation is complete.

The effectiveness of standpipe systems in buildings under construction is shown by the fact that not a single loss of any magnitude was paid on the Builders' Risk policy on the new Board of Trade Building in Chicago. Quite a number of rubbish fires did break out but these were readily extinguished by the first-aid equipment on hand or by streams from the hoses attached to the standpipe systems. For a building of its size, this shows a very favorable record.

That the use of standpipes in skyscrapers by the fire department might be better understood, let it be assumed that there is a fire on the 16th floor of such a protected building. Hook and ladder and engine company men proceed upon arrival to the scene of the fire by elevator to the floor directly beneath the fire or to the floor on which it is located. These men run the $2\frac{1}{2}$ inch hose off the non-automatic racks, and with the nozzle under control the valve is opened. Water is then played on the fire from a point where retreat down the stairway is possible and with all other necessary precautions. In the meantime the companies on the ground have connected to the siamese connections as many lines as seem necessary. The chief officer from a consideration of height, friction losses, required nozzle pressure, and entry head, has arrived at the number of pounds required to be added by the pumpers to the stream from the hydrants, to supply an effective stream. While a reasonable pressure is needed to give a satisfactory hose stream, an unnecessarily high pressure might cause damage to hose, apparatus, pumps, or even men. The pumps are then started, if there is any indication that the fire is of such a magnitude that there is need for quite a supply of water. More hose lines are brought into action as needed until the fire has been completely extinguished.

How much easier this procedure is than for the firemen to attempt to drag hose lines up 16 flights of stairs! Even if this were possible and the excessive pressure did not burst the special hose which would be required, the time elapsed in so doing would permit the fire to extend to such proportions as to destroy the building. The standpipe system is therefore a most vital part of the fire protection equipment of the world's taller buildings.

ALUMNI NOTES

NEWS OF ARMOUR ALUMNI ASSOCIATION AND OF ARMOUR GRADUATES

Open Letter to Alumni

THE Alumni Department of the *Armour Engineer* believes itself peculiarly fitted to serve you in the capacity of a unifying agent among the Armour graduates.

We are quite anxious to obtain whatever information or news that is available, concerning the projects and activities of our alumni. Such matters as marriages, deaths or births are of vital interest to your former best friends in school. Also of interest is the matter of changes of jobs or positions, either of your own or an alumni friend. Then, too, we are always on the lookout for news of projects or inventions completed by Armour men.

Do you know of some such item of interest, or fact, about yourself, or your work, or anything at all which you would care to have other alumni know of? If so, we will be only too glad to print it in our section of the *Engineer,* where it is certain to be observed and read by a considerable number of Armour students, present and past.

Officers Meet

ON Monday, April 16, at 6:00 P. M. an important meeting of the Alumni Officers of Armour Tech was held. The meeting place was the University Club. The following men attended: Prof. David Moreton, secretary and treasurer, A. A. Corman, L. A. Sanford, C. E. Striker, Harold W. Mundy, C. W. Burcky, J. W. McCaffrey, A. L. Eustice, Everett Cole, Morris Lee, and J. J. Schommer, president.

The principal purpose of this meeting was to fix a date for the Spring Banquet. After some discussion, the night of June 5 was selected as being the most convenient. The committee of three chosen to work out the details consists of Prof. Moreton, J. W. McCaffrey, and A. A. Corman.

During the discussion all present made it evident that what was chiefly desired was a much greater attendance than the usual. It was pointed out that inasmuch as financial conditions everywhere are improved, a much better representation could be expected. High class entertainment is assured since one hundred dollars were appropriated to provide the same.

This latter, however, will constitute only a portion of the entire program, for a key is going to be presented to that deserving alumnus who unselfishly has done a great deal for the Armour Tech alumni. There will also be another award, this latter being the annual alumni honor award to the graduate of the '34 class who has attained the highest all around distinction. Still another award will be bestowed upon the alumnus who has attained the most outstanding distinction in his profession.

The committee conferring on the above awards are Harold Mundy, A. L. Eustice, and Morris Lee.

The meeting was adjourned at 8:00 P. M.

From now on an effort will be made to sell life memberships in the Alumni Association. The price of this is $40 and is especially desirable because it includes an exemption from all further dues, and also a permanent subscription to the *Armour Engineer,* which periodical the owner of the life membership will receive quarterly for the rest of his life.

The Musical Clubs of Armour

THE Musical clubs of Armour Institute of Technology are to present their thirty-third annual spring concert at Armour Mission, Wednesday evening, May 16, at 8:00 P. M.

The home concerts, presented by the orchestra, glee club, and soloists, are very commendable performances, showing extraordinary talent among the engineers and providing most popular and unique entertainment.

It has been customary in the past for many of the alumni to attend, since it affords an excellent opportunity for them to renew acquaintances.

The officers of the organization are expecting a large alumni attendance, for it will excel all previous performances in brilliance, variety, and finish.

THIS department has received a most congenial letter from J. B. Wells, M. E., '07, which should prove to be of interest to alumni in general, especially to those earnestly looking for work. He states in brief:

"The very evident trend in this work (oil fields) is toward deeper and deeper drilling, and such depths will call for a great deal of work on the part of designing engineers employed by the manufacturers with collaboration on the part of oil company engineers.

"A great deal can be done by a man with some ingenuity, a knowledge of engineering principles and practice such as every Armour graduate must have.

"Work in the fields is often hard, but not beyond the capacity of a healthy young man. The pay, even for a beginner is better than in almost any other industry. At least that is the case in California."

Alumni Club Formed

PLANS for organizing as an alumni club were formulated by the present senior mechanical engineering class in a meeting held April 20th. The organization was originally planned in order to keep in close contact members of the class, and thus preserve friendships formed during the four years at Armour. Meetings are to be held periodically in the form of smokers or similar social get-togethers, the cost of which is to be defrayed by the individual members of the class. It was also decided that invitations to the various affairs be accorded the faculty members of the mechanical engineering department.

Herbert Kreisman was elected head of the organization, and a committee consisting of Diamond Dickey, Irving Kolve, and

Jerome Pinkus was appointed to assist in making all the necessary preparations for the smokers.

George J. Taylor, E. E., '25, who has been in the Commercial Engineering Department of the General Electric Vapor Lamp has been given a promotion and at the same time transferred to the company's home office in Hoboken, N. J.

Louis W. Chatroop, Civil '26, was shot and killed on the evening of April 14th by an unidentified gunman—presumably a robber—as he was driving his automobile into his garage in the rear of 6256 Wayne Avenue.

Mr. Eugene Spiegel of the class of '30 was married to Miss Jean Kruss at her home on December 1 of last year. Mr. Spiegel's only comment was that "we're happy!"

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An Open Letter

ARMOUR Institute of Technology achieved its enviable reputation through its activities as a strictly undergraduate engineering school. Curricula were developed with the view of training the student for the engineering profession in general and some specialized branches of engineering in particular. That there was a demand for this class of training was evidenced by full capacity enrollment, and that the training itself was effective is shown by the achievements of the graduates.

Statistics show that about 75 percent of the graduates of the Institute (all of these were trained under the old policy and cur-

ricula) have reached administrative and executive responsibility by the age of 45 or 50, and many are detached from technical work either wholly or in part. Only a negligible portion of the remaining 25 percent may be classed as "failures". What other profession has made a better showing? What changes in policy and curricula can effect a higher return?

That there is always room for improvement of curricula, administration, and teaching methods in engineering schools cannot be denied, but, what constitutes improvement? More social science—more business and accounting—more management and time studies—reductions or eliminations of engineering specialties—more years of academic training—more "what have you"? It takes years and years to prove that a certain line of training is more effective than some other line, and even then, the variable human element may cloud the issue.

Every alumnus, based on his own particular post-scholastic experience, has suggestions to make toward improving the educational program of his Alma Mater. If all these recommendations were incorporated in the curriculum a student would have to spend all his life in school, and even then fail to cover the requirements for graduation.

Why change the policy of a school which, under that policy, operates at full capacity and at the same time maintains an enviable reputation? If, during a financial emergency, changes must be made, why not leave to the last the features which made the school an educational success?

—Prof. G. F. Gebhardt

THE GUEST EDITORIAL

The New Citizenship

THE economic crisis from which our State and Nation are now emerging brought into being a new concept of citizenship. It emphasizes that passive acceptance of leadership without an understanding of responsibility therein is of no definite value to good government.

In genuine civic leadership there must be not only a willingness to serve but a thorough understanding of the problems of the Nation. In this new era, the person who is educated not only in his own profession but also in the general field of political science and economics and their practical application must inevitably assume a role in the front rank of the people.

The citizen of today and tomorrow, who would discharge his full duty, must take a more definite part in the solution of public problems. He owes it to himself to study the problems that confront local, State, and National government and must appreciate that, whether he serves in a public or private capacity, he is in some measure the government itself.

This new type of citizenship will make itself felt and will wield a tremendous influence in helping restore the United States to its former prosperity and to its place of beneficient leadership among the nations of the world.

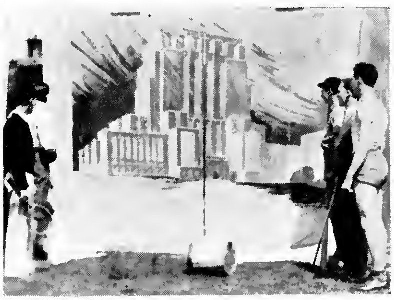
—Henry Horner
Governor of Illinois.

THE COLLEGE CHRONICLE

NOTES ON COLLEGE EVENTS, HONORARY GROUPS AND DEPARTMENTAL SOCIETIES

Junior Week

THE Class of 1935 will hold its week of glory beginning May 14. The class has selected three capable marshals, Jones, Hennig, and Lauchiskis, and they have arranged for some novel events amid the customary program. The schedule of events for the week is as follows:



Winning Stunt—1933.

Monday, May 14—Open House.
Tuesday, May 15—Pentathlon.
  Interclass Soft Ball Preliminaries.
Wednesday, May 16—Interclass Soft Ball Finals.
  Interfraternity Relays.
  Baseball—A. I. T. vs. North Central.
  Annual Spring Concert.
Thursday, May 17—Interfraternity Track Meet.
Friday, May 18—Interclass Relays.
  Junior-Senior Pushball.
  Frosh-Soph Rush.
  Interfraternity Circus Day.
  Junior Prom.

The Junior-Senior Pushball contest is a novelty this year and promises to bring out some of the old bitterness of several years ago. Another new feature is the awarding of second and third place ribbons in the pentathlon. Previously the only award has been a medal to the winner.

Preparations have now been completed and everything points toward a bigger and more successful week than ever before.

Baseball

THE first baseball practice began early in March with the pitchers and catchers working out in the gym. When the weather finally permitted the squad turned out for the first outdoor practice, preceded by a few chalk talks by the coach.

The squad now consists mostly of seniors who have had previous experience with the team. These are Reed, Mayer, Lucas, Vic and Tad Omeicinski, Lillis, and Cosme.

Don Jacobson is ably holding down his job as manager.

A very stiff schedule is faced this year,

Vic Hits Another.

Out at First.

considering that besides the league opponent there were four games with Big Ten teams of which two were won.

The boys have a good chance for the league championship considering the fact that most all of the first team consists of last year's men.

Reed, Lillis, Adomec, Lucas, Cosme, and Shewchuck have performed well in the outfield, the main part of the work being taken care of by Reed whose speedy legs take him all over the outfield at one time. The infield performs well with Tad Omeicinski at first base, V. Omeicinski at shortstop, Biegler at second and Al. Lauchiskis at third base. Lauchiskis, a new man on the team this year, performs well at this position and his batting is an asset to the team. The pitching duties are taken care of by Lefty Mayer who pitched brilliantly last year and who is the team's mainstay in '34. Baumel, Morrelli, and Machinis last year men, and Hayes, a newcomer, with Mayer, form the bulk of the pitching staff. Plenty of reserve material is to be found in Bothwell, Olson, and Winel. Bartusek, Lucas, and Phillips have been doing the catching for Tech, while Bacci and Knittel are ready substitutes in case of need.

The remaining part of the 1934 schedule reads as follows:

Wed., May 16 — North Central at Armour.

Sat., May 19—Armour at Elmhurst.

Tues., May 22—Lake Forest at Armour.

Rear Row (left to right): Krafft, coach; Reed; Lauchiskis; V. Omiecinski; Lillis; Bartusek; Baumel; Olson.
Second Row: Jacobson, m'g'r; Winel; Bacci; Ma-hinis; Cosme; Phillips; Scheucheck; Bothwel.
Front Row: Morrelli; Adamec; Biegler; T. Omiecinski; Fotter; Lukas; Hayes; Mayer.

Tau Beta Pi

SIX men were initiated into Tau Beta Pi on Friday, April 6. These men were:

A. J. Anderson, '34.
G. F. Korink, '34.
W. B. Ahern, '35.
A. E. Lauchiskis, '35.
E. N. Searl, '35.
G. W. Wheaton, '35.

The initiation was preceded by a banquet held in the Faculty Grill. Later all members attending, numbering about thirty, went to the Cort Theatre and saw the play, "The Curtain Rises" A number of faculty members attended the initiation.

Chi Epsilon

THE beginning of this year saw the formation of a chapter of the civil engineering honorary fraternity at the University of Missouri. This brings the total up to twelve chapters scattered over the United States.

The local chapter pledged two men on April 16, at the Phi Pi Phi House. They are:

Barclay Jones, '35.
Joseph M. O'Connor, 35.

This will leave four actives to carry on next year.

Eta Kappa Nu

THE annual spring election of the Eta Kappa Nu national honorary electrical engineering fraternity was held on April 16th. After the routine business had been attended to the following men were pledged:

D. N. Chadwick.
J. Morrissey.
V. Hedlund.
L. Higgins.

Selections of pledges to Eta Kappa Nu are based primarily on scholarship and on the individual attainments of the candidate. These pledges will be initiated early next semester.

Phi Lambda Upsilon

EARLY in April Dr. George H. Coleman, national vice president of Phi Lambda Upsilon, visited a meeting of the Armour chapter. A round table discussion was held and Dr. Coleman explained the proposed new constitution.

A formal initiation was held at the Phi Kappa Sigma house on Thursday, April 13. The following men were initiated:

Jack N. Weiland.
Elmer P. Renstrom.

Each initiate gave a very entertaining talk on a subject assigned to him. After the initiation a round of bridge was enjoyed. Later refreshments were served. A large number of actives, faculty members, and alumni attended the meeting.

During the first week of May a number of junior chemicals ranking highest in their class were pledged. These men will be initiated before the end of the semester.

Sphinx

LAST week the following men were initiated into Sphinx, the honorary literary fraternity:

From *The Armour Tech News*—
Edward Searl, Editor-in-Chief.
Richard D. Armsbury,
Managing editor.
William B. Ahern, Sports editor.
From *The Armour Engineer*—
Ellis Doane, Editor-in-chief.
Stanley Berstein, Technical editor.
From the *Cycle*—
George Wheaton.

These men had served a pledgeship of about a month. They were pledged during a meeting held at the Theta Xi house on April 17.

Pi Nu Epsilon

PI Nu Epsilon, honorary musical fraternity, takes pleasure in announcing the pledging of the following men:

L. W. Mecklenberg, E. E. '35.
C. P. Grakavac, C. E. '35.
J. H. DeBoo, M. E. '35.
J. K. Morrison, F. P. E. '35.

The pledging took place April 19 following a smoker held the previous week at the Theta Xi Fraternity House. At this smoker the candidates were submitted to a very thorough examination regarding their qualifications and musical knowledge. At the present time the constitution, and ritual of the fraternity as well as its policies are undergoing a thorough revision in an effort to advance the cause of music at Armour.

Scarab

FIVE men were pledged to Scarab at a dinner meeting held April in the Men's Grill of Marshall Field and Company. The men pledged were:

Leonard H. Mayfield.
Malcolm C. Forsyth.
Walter H. Larson.
Ivar VieheNiess.
Wesley S. Wieting.

Edgar Miller, a recent winner of an Art Institute prize, addressed the gathering.

Alpha Chi Sigma

ON March 19th Alpha Psi of Alpha Chi Sigma initiated in the rooms of the fraternity the following men:

Charles T. Clark, '36.
Robert M. Paulsen, '36.
Algird Rulis, '36.
Leonard Robbie, '36.
Alvin J. Ragan, '36.

The pledges at present are:

Howard P. Milleville, '36.
Robert C. Peterson, '36.

To celebrate the initiation a dinner dance was held in the Walnut Room of the Bismarck Hotel on March 23rd.

J. R. Lang, the delegate from Alpha Psi, will accompany the representation from Northwestern University and Mr. L. W. Van Doren, the District Counselor, to attend the Alpha Chi Sigma convention to be held in Indianapolis this summer.

THE TECHNICAL BOOKSHELF

REVIEW OF NEW BOOKS OF ENGINEERING AND SCIENCE

Electrons and Waves

By H. Stanley Allen
Macmillan & Co., London

PHYSICAL science, like many other subjects, has several theories which attempt to explain the observed phenomena in various ways. Due to rapid progress in the study of the subject, many new theories are advanced and old ones discarded. There remain, however, several hypotheses, one of which seems just as true in some respects as the others, yet no facts are known to disprove any of them. The book gives us the history of these various theories, and the facts supporting them. It is, in reality, an introduction to the subject of atomic physics and is based upon lectures delivered by the author to the students of the University of St. Andrews.

The author has attempted to follow a middle course in the presentation of his subject, so that his work will be intelligible to the layman with little knowledge of the fundamentals of physics and at the same time both interesting and educational to the expert in the field. He has therefore not eliminated the mathematical side of the subject entirely, but has included only the more simple algebraic equations.

A discussion of the development of the atomic theory from the time of Democritus up to the present period is given in the opening chapters of the volume. The re- are also discussed, as well as the problem stricted and general theories of relativity of radiation as concerned with the quantum hypothesis. The subjects of photoelectricity, structure of the atom, Röntgen or x-rays, crystal analysis and x-ray spectra, radio activity, and the origin of spectra, are taken up in detail. Such theories as those of de Broglie and Schrödinger and the applications of the quantum theory are also included, while the entire closing chapter is devoted to summarizing the contents of the book.

Beryllium

Translated by Richard Rimbach & A. J. Michel
Chemical Catalog Company, Inc.

USEFUL applications for beryllium, an element discovered well over a hundred years ago, have not been known until recently. At the present time, however, there is every reason to believe that its utility as a resistant to corrosion and erosion and as a substance to be alloyed with other metals will make the element quite important. The book, therefore, enumerates the various chemical and physical properties of beryllium and the means of producing and using it. It consists primarily of reports of experiments carried out with the element in Siemens and Halske Research Laboratories.

The book describes in detail the analytical chemistry of beryllium and the methods of determining it quantitatively in the

presence of various other substances. In giving an account of the electrolytic production of the element, the method of producing beryllium salts suitable for electrolysis is discussed, as well as the means for obtaining deposits of beryllium by high temperature electrolysis and the direct electrolytic production of beryllium alloys. Quite a few pages in the volume are devoted to the alloys of beryllium with copper, nickel, iron, aluminum, and silicon. Under this heading is given an account of the physical properties of the copper alloys, together with a description of the structure, age hardening, and changes in electrical conductivity, volume, modulus of elasticity, and microstructure of the copper-beryllium alloys. A theory of the age hardening process of this substance is also included.

The volume contains many illustrations, and a brief but rather complete summary is made at the end of each chapter.

Chromium Plating

By Edward S. Richards
Charles Griffin & Co., London

ALTHOUGH it has been developed only within the past decade, the art of chromium plating is fast becoming one of the most common means of beautifying and preserving the surfaces of various articles. The coat of chromium produces not only a brilliant surface but a corrosion-resisting skin that is difficult to equal by any other means. However, the successful application of the chromium plate is a task that requires a certain technique, and it is to this latter problem that the book is devoted. The chemical and theoretical side of the subject is not taken up in any great detail, for the volume is intended primarily as a handbook for the actual chromium plater.

After a general discussion in the opening chapter concerning the applications of chromium plating and the common methods of applying it to various substances, several of the subsequent chapters are given over to a description of the layout and operations of a chromium plating plant. The shop in which the actual plating is done, with a description of the various vats and cleaning tanks and the source of electric power, is discussed in this section. In describing the cycle of operations to be followed in plating an object, an account is given of the cleaning processes preparatory to plating, the method of applying the inner coats of copper and nickel and the final coat of chromium, and the intermediate as well as final polishings. The application of chromium plate to various substances such as aluminum, wood, plaster, glass, etc., is described, and a short chapter giving rules for the protection of the workmen is included.

TECHNICAL ABSTRACTS

CONDENSATIONS OF LEADING ARTICLES IN THE TECHNICAL PERIODICALS WITH PERMISSION OF AUTHORS AND PUBLISHERS

Flying in the Fog

(From Science, March 2, 1934)

HOPES that flying in foggy weather could be made safer by the use of infra-red radiation were blasted by scientists and engineers gathered in Washington at the request of the Bureau of Aeronautics of the U. S. Department of Commerce for a conference on the problem of overcoming the hazard of fog.

There is no known source for obtaining infra-red radiation of the wave-lengths necessary for penetrating fog in energies of more than a few millionths of a millionth of a volt, it was pointed out by Dr. Irving Langmuir, of the General Electric Research Laboratory, and others in the discussion. No one knows how to produce this type of radiation in useful amounts. The discovery of a way to produce such radiation would be a stroke of genius and is not likely to occur in the course of routine experimentation.

The scientists also discouraged governmental experimentation with proposed schemes for dissipation of fog by use of the Tesla coil and other means. Such plans have been tested for many years, but Dr. W. J. Humphreys stated that it is well known to physicists that it is theoretically impossible for them to work well enough to be of practical use. Those that are based on sound scientific principles are too expensive to be considered for use in aviation.

Two possible solutions to the problem of fog landings were, however, given sanction by the meeting, and intensive research along these lines was urged. The first aid to the fog-bound fliers will be the radio. It is known positively that radio will penetrate fog. And radio signals can indicate to the flier, by the use of instruments, his location with reference to the flying field. It is true that they do not give distances shorter than the length of the radio wavelength used, but it is now possible to use wave-lengths as short as 10 meters for this purpose.

Another aid which further research may adapt for the use of the flier is the device used by vessels to determine the depth of the water beneath the hull by measuring the time required for a sound to return as an echo. A similar device has already been tried on airplanes, but at present it is necessary for the flier to judge from the loudness of the sound how far he is above the earth. It would be quite possible to have an instrument pick up the echo and show on a dial the height of the plane in feet above the ground. Such an instrument would help a great deal in lessening the dangers of flying in foggy weather.

Volumetric Method for the Determination of Sulfur in Coal and Cokes

(From The Fuel Economist, March, 1934)

THE objective of the originators of this report, Evald L. Shaw, Department of Chemistry, Trinity College, Hartford, Connecticut, and I. Laird Newell, Henry Southern Engineering Corp., was to hasten the process of the determination of sulfur in coke and coal as against the generally adopted methods while at the same time retaining the accuracy and ease of manipulation of the latter type so as to develop a suitable volumetric method which would be particularly advantageous for routine determination. The methods involving the formation of sulfides by a thermit reaction with subsequent evolution of hydrogen sulfide and titration require a very precise and definite technique to produce satisfactory results. Titration of sulfates with barium salts is subject to interference by appreciable amounts of calcium, nitrates, or ammonium chloride.

The procedure involved in the determination of the sulfur content is described as follows: Weigh 1 gram of 60-mesh coal into the bomb calorimeter tray; use a smaller sample if the sulfur content is high. (An Emerson gold-lined bomb with a silica tray was used in this investigation.) Adjust the ignition wire (iron is satisfactory) and add a few c.c. of water to the lower cup. Fill the bomb with oxygen to a pressure of 20 to 30 atmospheres, depending on the size of the bomb used. Take care not to add oxygen so rapidly as to disturb the sample. Set the bomb in cool water, and if no leaks are present, fire and let stand in water for not less than five minutes. Remove the bomb from the water and reduce to atmospheric pressure, taking not less than one minute. Wash carefully all parts of the interior of the bomb, including the tray, with a saturated solution of benzidine sulfate collecting the washings in a 250 c. c. beaker.

The volume of the washings should be 100 to 150 c.c. Add 60 c.c. of saturated benzidine hydrochloride solution slowly and with constant stirring. (It has been found that the slow addition of benzidine hydrochloride solution to the sulfate solution gives a precipitate which filters much more rapidly than if the precipitation is carried out by the reverse procedure.) The precipitate formed settles rapidly and can be filtered immediately on a small, medium paper. Wash the precipitate with saturated benzidine sulfate solution until free from acid. Return the paper and precipitate to the original beaker, add 100 c. c. of distilled water, and macerate the paper with a stirring rod. Titrate with 0.064N sodium hydroxide solution, using 1 c.c. of phenolphthalein indicator solution. Just before the end-point is reached, bring the solution to boiling and titrate to a faint pink. The number of c.c. of alkali used divided by 10 gives directly the per cent of sulfur if exactly 1 gram of the sample is used.

Earthquake in Japan Affects Tide Gage in Golden Gate at San Francisco

(From Engineering News-Record, February 1, 1934)

A RECORD of the Japanese earthquake of March 3, 1933, at San Francisco draws attention to the fact, well known to

seismologists that seismic shocks travel long distances across bodies of water in the form of stationary waves or seismic sea waves. On that date abnormal water-level fluctuations occurred just inside the Golden Gate and, although of a continually decreasing amplitude, these fluctuations were strong enough to continue to show on an ordinary tide gage for more than 24 hours. The same phenomenon has been observed over a period of years, whenever there was a severe earthquake in Japan. On the other hand, shocks originating along the Pacific coast usually do not register on the San Francisco tide gages. One suggested explanation is that shocks of oriental origin are believed to result from vertical movement of the ocean's bottom, and that this type of seismic disturbance propagates a seismic sea wave, while horizontal movements of the earth's crust do not. Vertical displacement of earth crust actually in contact with water is said to be a prerequisite to propagation of seismic sea waves. Land shocks may be felt on water near by, but seismic waves not of submarine origin do not travel long distances through water.

The rate of travel of seismic sea waves is reported to vary with water depths and other conditions from 375 to 450 m. p. h. Some long distance effects are on record: a quake in Ecuador was felt in Sukahori, Japan, 9,992 miles away, and another in Valparaiso was recorded at Kushimoto, Japan, 10,937 miles distant. As such oscillations diverge from the epicenter, they diminish rapidly in amplitude. At first they become long, low swells, perhaps 100 or 200 miles in length, but at distances of a few thousand miles they no longer resemble sea waves, partaking more of the nature of miniature tides with a period of 20 to 30 minutes.

In a recent report of the National Research Council the subsidiary committee on oceanography pointed out that despite its slight compressibility, sea water responds as an elastic body to the short-period oscillations of submarine earthquakes, the velocity of progression in these oscillations being equal to that of sound. To a ship on the surface of the ocean they manifest themselves by a sharp and sometimes violent shock much like that caused by a vessel striking a reef. This accounts for the numerous reefs shown on old charts, which are proved to be non-existant by oceanography.

Fortifying Concrete Against Marine Attacks

By G. R. Skerrett

(From Compressed Air Magazine, February, 1934)

THE task of the harbor engineer is the construction and maintenance of piers and wharves. The first wharves were made of wood, which did not last long due to the destructive action of several species of mollusks, commonly known as shipworms. These shellfish, brought by tidal currents, attached themselves to the wooden piles and bored holes, undermining the structure, the region of the attack being the area between high and low tide levels.

The first method adopted to eradicate the evil was to creosote the piles. The plan was forced upon the authorities after a climax was reached in the period 1917-

1920, when more than $20,000,000 damage was done to Pacific harbors. This method was not very satisfactory for the protective coating was carelessly applied. The wooden piles were soon replaced by supports made of concrete, reinforced by steel. The advantages were soon apparent; (1) the concrete piles were non-inflammable, (2) concrete piles, when properly made, were the best defences against the destructive shipworms. These new piles soon began to fail in service, and the reasons ascribed to the failure were: (1) erosion and abrasion by waves and small particles held in suspension by the water, (2) chemical action of salt water on the concrete, (3) scaling and cracking due to changes in temperature, (4) cracking due to forcible expansion resulting from the oxidation of the steel, which is exposed to the water in the pores of the concrete.

The third and present method in use is giving satisfactory service. The concrete is treated with asphalt at elevated temperatures for 15-24 hours. The pile is cast of two different mixtures, the core having a strength of 4,000 lb./sq. in., while the jacket is made of a more porous mixture. The two mixtures are cast simultaneously the cylindrical shell separating the core from the jacket being withdrawn as the pouring proceeds so that the two mixtures form an integral part when they are dry. The green piles are cured for 60 days and then transferred to a preheating chamber where they are heated to a temperature 250° F., the time for performing the operation being 18-20 hours. The dehydrated piles are then transferred to the creosoting tank, a steel tank 8 ft. in diameter, 82 ft. in length, and capable of being hermetically sealed. The tank is evacuated and hot asphalt under an air pressure of 100-150 lb./sq. in. is forced in. The temperature is kept at 250 degrees for an hour and allowed to drop to 100° F. in from 10-14 hours. The asphalt is forced out by the compressed air and the piles transferred to a draft-free chamber where they cool gradually. These piles can be counted to give a service life of 75 years.

Slabs of concrete similarly treated may be used where excessive abrasion, corrosion by gases and liquids and erosion exist, such as linings of wharves and piers, sewers, and pipe. The slabs are joined together by pouring hot asphalt into grooved lap joints. The heat softens the surrounding pitch, making a perfect bond when cooled. The slabs when thus bonded have successfully withstood a hydrostatic pressure of 50 lb./sq. in. without leakage.

Abrasives in Metal Polishes

By C. S. Kimball

(From Chemical Industries, March, 1934)

IN making a polish several factors must be considered, (1) relative size of the particles, (2) settling characteristics of the abrasive, (3) sharpness of the particles, (4) protective colloidal action of emulsion stabilizers, (5) the electrical charge of the suspended particles, (6) the function of buffeting agents as affecting the cutting by the abrasive, (7) the formation of metallic soaps on the surface, and (8) the suspending and carrying away of the particles of corrosion that have been removed by the polish.

Four main types of polishes are sold in the American market along with many special brands. The types of polishes are: (1) neutral, naphtha base polish; (2) naphtha base ammonia polish; (3) water base pine-oil polish; (4) water base ammonia type polish. The oldest type is the neutral, naphtha base type which was a mixture of gasoline and silica. The purpose of the gasoline was the removal of grease while the corrosion was removed by mechanical abrasion. The present variations contain a fatty acid of a high melting point. The fatty acid reacts with the metal surface, forming a water insoluble soap which protects the surface to some extent. It also imparts a hue to some metals, especially to nickel, which takes on a bluish tint hiding the silvery sheen of the pure metal. This type is the most efficient but its use introduces a serious fire hazard as the vehicle is usually gasoline or naphtha. Another objectionable property is that a cake is formed on standing, for the abrasive is not in suspension or even semi-suspension.

The naphtha base ammonia types are the same as the neutral naphtha base types except that an ammonium soap is added as well as an excess of free ammonia. The ammonia soaps are unstable, forming a fatty acid and ammonia on decomposition, the ammonia escaping in the polishing operation. Theoretically, this type is the most efficient, but the objection encountered is that it is very gummy, this being explained by the fact that the heavy metallic soaps formed in the polishing are sticky. These metallic soaps are difficult to remove and a large excess of the soap dulls the luster.

The water base metal polish is a modified form of the naphtha type, consisting of a mixture of silica and water, colored pink for some forgotten reason. The first die used by the manufacturers was rhodamine, and they consequently were faced by the same problem, for the die decomposed, changing from pink to yellow. The quality of the polish was unchanged but the reaction of the customer may well be imagined. The problem was finally solved by using oil soluble dies.

The pine-oil type polish is an emulsion of sharp silica in pine oil stabilized by the addition of soda soap. The silica is kept in suspension by the protective colloidal action of the oil. It is the cheapest polish to produce and was the longest in use. It formerly had a wide spread use, but has since dropped off the market. It is the least efficient polish because its viscosity makes it a wasteful process. Another reason for its rejection was that it left a clinging pine-oil odor and required more labor to produce a satisfactory luster.

The water base ammonia type is the most important liquid metal polish. It consists of an aqueous suspension of silicious matter in water, stabilized by soap. It usually contains colloidal clay or a heavy metal soap as an additional stabilizing agent. Salts of organic acids are added, these having a cleansing action far superior to ammonia. It is interesting to note that the U. S. Navy notices this fact and that it requires that a polish must remove chemically the affects of corrosion produced by ammonia on brass before it can pass the navy's specifications. Its use is not restricted as it is non-inflammable.

Special polishes are sometimes em-

ployed, but they are generally too expensive to adopt commercially. The cyanides, antimony compounds, and other poisonous materials are prohibited by federal and state laws. Although they are good cleaning agents, they can be replaced by other chemicals which are just as good and not nearly as deadly. Nitrobenzine is used chiefly for the odor it imparts to the polish, but is present in quantities too small to injure the workman's health. The properties making the paste polishes objectionable are their gummy natures and difficulty of application under temperatures of 70° F.

The abrasive most commonly used by the industry is silica, either in the crystalline form or as pumice. The grade most suited to the particular job is selected after suitable experiments have been performed. An abrasive that is too mild will give a poor luster.

Charcoal Gas Driven Road Vehicles

(From Gas and Oil Power, March, 1934)

EQUIPPED with a "producer-gas-plant" a 25 H. P., 15-20 cwt. Ford van staged a successful demonstration of the far-reaching possibilities of this and similar gas as a substitute fuel for petrol in internal combustion engines. The "producer-gas-plant" was fitted on the side of the vehicle above the forward end of the running board. The gas was led through the cleaners situated at the back, suspended between the rear wheels, and from there to the induction manifold on the off side of the engine. Before the gas pipe joins the manifold an air inlet is provided, the amount of air being controlled by a lever fitted in the driving compartment. When once set, the air valve rarely requires re-setting. A gas throttle is used in place of the orthodox petrol throttle. On the left hand side of the dash a drip feed is fitted to introduce small quantities of water from a tank into the gas pipe as it leaves the gas generator, thus enriching the gas. The air intake to the generator, it may be noted, is warmed by the gasses leaving it. On the van tested, a patented cylinder head is employed, and provision is made for starting on petrol when considered desirable.

Charcoal was the fuel used, and enough can be carried to cover a distance of 50 miles. It has been stated that 12-15 lb. of charcoal would be equivalent on this vehicle to one gallon of petrol.

The behavior in traffic of this demonstrative vehicle was especially satisfactory. The trip was made in the most crowded London thoroughfares and, as a result, tested the full reliability and handling of the system in traffic conditions. The engine must be kept at higher idling speed than the ordinary petrol vehicle in order to maintain the gas flow; this involves the more frequent use of the clutch due to the greater number of revolutions of the engine. In practice this means declutching rather early in coming to a standstill or changing down to lower speeds in good time so as to keep up the engine revolutions. The engine, incidentally, ran with a marked smoothness. Power and acceleration are less than on a similar petrol van. This is to be expected, since the test was not run to demonstrate advantages on these scores.

Table of Running Costs with Charcoal and Petrol at Various Prices per 100 mile run

	PETROL COST PER GALLON													
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
	1	0	1	6	2	0	2	6	3	0	3	6	4	0
Petrol	7	3½	10	1½	14	7½	18	3	20	3	24	9	29	3
10 s./ton charcoal...	0	3½	0	3½	0	3½	0	3½	0	3½	0	3½	0	3½
Petrol	7	3½	10	1½	14	7½	18	3	20	3	24	9	29	3
20 s./ton charcoal...	0	7	0	7	0	7	0	7	0	7	0	7	0	7
Petrol	7	3½	7	3½	7	3½	7	3½	7	3½	7	3½	7	3½
30 s./ton charcoal...	0	10½	0	10½	0	10½	0	10½	0	10½	0	10½	0	10½
Petrol	7	3½	7	3½	7	3½	7	3½	7	3½	7	3½	7	3½
40 s./ton charcoal...	1	2	1	2	1	2	1	2	1	2	1	2	1	2

Seven minutes are required to start the installation in the morning, after which, on stopping the engine, the fuel will continue to burn, and the engine may be restarted through the utilization of a hand driven fan which creates the initial gas flow.

The greatest attraction of this form of power is the cheapness of the fuel. As a result of the test opinion has it that producer gas plants should be particularly applicable to commercial vehicles which operate over long distances, suitable for bus and lorry operation, and for farm tractors.

Whatever fuel is used, economy of a high order is attained, it being possible to market charcoal at about £4 a ton. The price of low temperature coke varies from 1s, 601 to 3s per cwt. Consumption of the low temperature coke amounts approximately to 1.1 lb. per B. H. P. per hour, and that of charcoal to approximately 1 lb. per B. H. P. per hour. The amount of the drip water feed used for enriching the gas is practically negligible, and averages about ¼ gallon per hour.

Analysis of costs for ploughing with tractor using low temperature coke at 3s. a cwt. and paraffin at 10d a gallon, showed a saving over paraffin of 60 per cent. The accompanying tables give a further illustration of economies gained.

The possibilities of further development of this type of vehicle propulsion are tremendous. The owners of large timber resources can produce their own charcoal, besides plants for various road transport duties, arrangements are being made to adapt several small pleasure craft to this form of fuel.

There is little doubt in view of the satisfactory operation of this plant, that equipment of the type described has a promising future for certain classes of light commercial vehicles, agricultural tractors, portable engine installations, etc., which have previously operated on petrol and similar fuels.

ENGINEERING PROGRESS

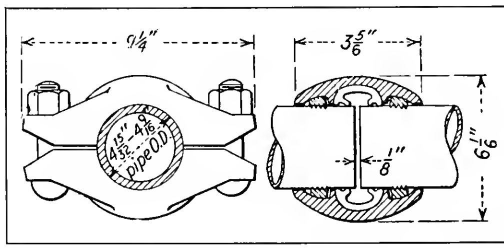
NEW DEVELOPMENTS AND DISCOVERIES IN SCIENCE AND INDUSTRY

Combination Float-Thermostatic Trap

THIS steam trap is a combination float-thermostatic one, and has working pressures up to 180 lbs. per square inch. The trap is compact in design and light in weight and can be supported directly on the piping. The inlet and outlet are on the same side, a small vertical distance apart for easy connection to horizontal pipes. All working parts are on the cover and can be exposed for cleaning by removing the trap body, without disturbing the connections. The automatic air by-pass is arranged on the down-board side of the trap so that the thermostatic element is not exposed to the full steam pressure. It will keep the trap vented at all times so that it cannot become air-bound. The main discharge valve and seat are of stainless steel for long life and freedom from scoring. The capacities of these traps vary from 1900 to 2100 pounds of water per hour.

A Gasket-Type Coupling

A SIMPLE coupling which it is said can be readily assembled by cheap labor is shown in the figure. It is called the "Plain End" coupler. With its use, the joint can be broken and made again any number of times without impairing the coupling's efficiency. It was developed to facilitate the laying of pipe lines with straight plain end pipe which does not have to be subjected to an extra finishing operation, such as grooving or upsetting the ends, threading or beveling. At the same time, it is said to provide strength, in tension sufficient to

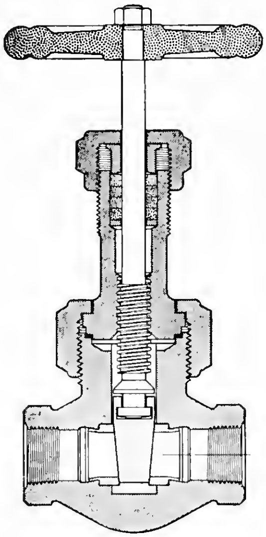


meet all strains met in the line. The coupling has five parts: two half couplings which contain the gripping device, one gasket with metal-protected sections, and two bolts. These are of drop forge special steel, the gripping rings being hard treated as well, to produce a hard section, and assembled into half couplings so as to become integral with the coupling itself. The coupling has proved its worth by being tested successfully up to 4,000 pounds pressure per square inch.

Plug-Type Valves

FOR severe service demanding maximum resistance to destructive action on valve seat bearings, a new valve with plug-type alloy seats and discs has been developed. The alloy is a non-galling, non-ferrous composition of great hardness, and is resistant to wear, abrasion, erosion, and

corrosion, retaining its hardness at high temperatures. These valves are made with full length, deep seated plugs. Each plug is ground into its own seat, to insure a leak-



proof fit. All parts of these valves are interchangeable, except the bodies and bonnet rings. These valves require little attention and give excellent results.

A Crankless Diesel Engine

THE first crankless Diesel engine has just been built. It is a two cycle engine having no crank shaft or cam shafts, no cylinder heads, no valve or cylinder head gaskets, and is materially reduced in weight and size. It runs on the lowest grade of fuel oil and the predicted fuel cost is estimated at seventy-five per cent less than the cost of fuel for a gasoline engine of equal power output. Depending upon the size, the weight of the new engine ranges from thirteen to twenty pounds per horse power as against fifty to eighty pounds in the conventional Diesel. The absence of many conventional parts has reduced vibration and noise, maintenance care and expense. The pistons traveling horizontally contribute to the smoothness of operation, longer service and reduced height of the engine. The engine starts more positively than a gasoline engine and accelerates rapidly and uniformly. It incorporates the simplest movements yet designed in an internal combustion engine. In this development of a prime move with a great range of speeds (from 200 r. p. m. to maximum); freedom from vibration; flexibility of control, the goal of Diesel engine designers has been more closely reached than ever before.

Temperature Regulator

A NEW electric temperature regulator comprising of automatic valves for steam, gas, oil, or brine flow control, and actuated by thermostats of various kinds, are fitted with a "heat motor" to operate the valves. This motor consists of a pressure chamber in which a volatile fluid is vaporized by an electric strip heater. The vapor pressure thus built up, compresses a flexible bellows in the chamber. The valve plunger is attached to this bellows, and is moved upwards when the bellows is compressed. Limit switches, actuated by the valve stem itself, control and reverse the valve stroke. An ingenious device for interrupting the electric circuit makes it possible to arrest the valve travel at any point between the "open" and "closed" positions. It is claimed that six different valve positions can be obtained for a total temperature difference at the thermostat

of only one degree Fahrenheit. This makes possible extremely close control of temperatures even where fluctuations occur rapidly over wide limits.

Ultra-Violet Radiation Meter and Indicator

TWO new instruments are announced for the measurement of radiation in the region between 2800 and 3200 A. U. One registers the amount of such radiation falling on a unit surface in a given time and, therefore, is a meter; the other furnishes an instantaneous reading of the strength of any given source, and thus is an indicator. The integrating meter consists essentially of a cadmium type phototube serving as a radiation receiver, a d. c. amplifier employing a screen-grid tube and dry batteries, and a four-digit cyclometer counter. In operation, the photocell output accumulates on a capacitance until it reaches a sufficient quantity to cause discharge, thereby actuating the counting relay, and the process is repeated as long as the receiver is exposed to ultra-violet radiation. The unit thus counted is the "E-viton" proposed by Luckiesh. (One E-viton (10 u w) per cm.^{2}=1 erythemal unit.)

Aluminum Mirrors

A PROCESS for coating glass with aluminum has been developed which gives a high quality mirror surface having many advantages over silver mirrors. The new mirror reflects all wave lengths of light alike and with an efficiency of ninety-three per cent. Silver mirrors have about the same efficiency with red light but only eighty-one per cent with violet light and less with ultra violet.

The aluminum coating is tough, durable, and can be "laundered." The aluminum surface develops an invisible coat of aluminum oxide which protects the metal without tarnishing and which can be washed over and over with soap and water. Silver, on the other hand, has a delicate surface which is easily scratched and corroded. On the metal front mirrors, silver also has a tendency to distort colors; whereas the open surface of aluminum unhampered by refraction and absorption, gives undistorted, properly colored, realistic images not seen hitherto by the ordinary mirror gazer.

In the manufacture of the new mirrors it is first necessary to get the surface of the glass really clean. What is clean enough for silver plating is by no means satisfactory for aluminum. The final contamination is blasted off the surface by a bombardment with electrons and ions. The surface is coated with aluminum by means of the vapor plating process. Dr. J. Strong of the California Institute of Technology uses pure aluminum in the process; Dr. H. Edwards of the University of California uses a special aluminum alloy. The metal, placed next to the glass, is electrically heated to a very high temperature in an extremely high vacuum. In this high vacuum the metallic vapors formed pass over to the glass, where they condense to form a brilliant mirror.

The largest mirror so far coated is the thirty-six inch reflector of the Lick observa-

tory. The coating was applied by Dr. Strong. It required a vacuum chamber big enough for several people to sit in. Preparations are now being made for coating the new giant 200-inch mirror for the telescope at Pasadena.

The aluminum mirror will replace the silver mirror in many other instruments. Motion picture producers already have installed reflectors of aluminum mirrors for the purpose of illumination with the expectation of lowering the terrific amount of electricity they use for such purposes. As much as 45,000 amperes at 110 volts—enough to light a fair sized city—are used for single scenes. Reflectors are necessary because it is neither desirable nor practical to throw the direct glare of huge lamp batteries directly on the actors' faces. By replacing silver mirror reflectors, which have a very low efficiency in blue and violet light recognized to be so valuable in photography, with aluminum mirrors, great economy, as much as fifty per cent, in energy consumption is expected. Furthermore, the excellent rendering of color value promises usefulness in exhibition as well as in production.

● "I see she's let her hair go dark again."
"Yes—off the gold standard."

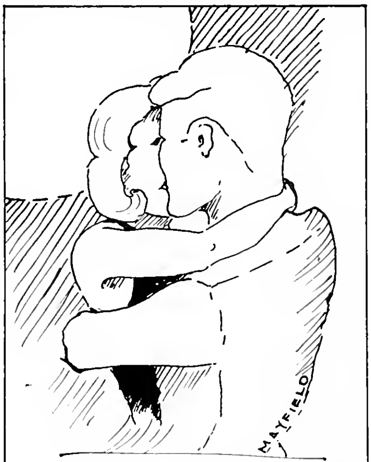
● Ho: "Do you think colleges turn out the best men?"

Bo: "Sure thing! I was turned out in my freshman year."

● He used to walk in the moonlight with one arm full. Now he walks in the bedroom with both arms full.

● Alpha: "Brother, what is nationalization of property?"

Beta: "It's what happens to your things when you live at a fraternity house."



HEAT RISERS

● Doctor: "I dislike mentioning it, but the check you gave me has—er—come back."

Patient: "That's funny, doctor—so have my symptoms."

● "Tomorrow evening I'm going to the suburbs to see a model home."

"That's great! See if she can get a friend for me."

● Definition—A kiss is a noun, though often used as a conjunction. It is never declined—it is more common than proper and is used in the plural and agrees with all genders. —Red Cat.

● Betting, says a church paper, is essentially a means of getting something for nothing — or vice versa.

● 'Twas in a restaurant
they met,
Romeo and Juliet.
He had no cash to pay
the debt,
So Rummelo'd what
Julie't.

● "I draw the line at kissing,"
She said in accent fine;
But he was a football hero,
So he crossed the line.

—Buccaneer.

● Dilly: "Don't you think the Mills Brothers are great?"

Dally: "I'll say, especially the one with the red hair who plays the harp."

● The only one who should put faith in a rabbit's foot is a rabbit.

● Artist: "I would like to see some camel's hair brushes."

New Girl: "Don't be funny—so would I!"

● Then there's the guy who became father of such ugly twins that he went down to the zoo and shot all the storks.

● Mother (to her little dear): "Hush, dear, the sandman will soon be here."

Pride and Joy: "O. K., Mom. Gimme two lollypops and I won't tell daddy."

"Our boss has discharged two pretty stenos today."

"Isn't it rather early to be canning peaches?"

● The young lady walked boldly up to a woman whom she assumed to be matron of the hospital.

"May I see Lt. Barker, please?"

"May I ask who's calling?"

"Certainly; I'm his sister."

"Well, well. I'm very glad to meet you. I'm his mother."

● The telephone operator is actually our friend—she's always plugging for us.

● "Pa."

"Yes, my son."

"What's a flapper?"

"A flapper, my son, is a woman who does what an old maid would like to do and hasn't the constitution to stand it."

—Exchange.

● The old stand-by (hopefully)—"Let's—er—get married!"

The old stand-up—"Why, who'd have us?"

● Professor (looking at examination paper)—"Why all the quotation marks on this paper?"

Student—"Courtesy to the man on my left, professor."

● Greatly agitated, a woman carrying an infant dashed into the drug store.

"My baby has swallowed a bullet," she cried, "what shall I do?"

"Give him some castor oil," replied the druggist, calmly, "but be sure you don't point him at anyone."

—Earth Mover.

● It is said that Samson was a great advertiser. He took two columns and brought down the house.

Selling by telephone gets results. In many lines of business, salesmen are finding they can cover more customers more often—and close more sales at lower cost—by telephone.

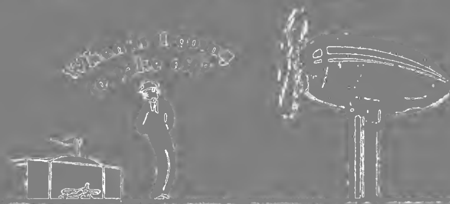
Bell System men have worked out a number of plans for systematic market coverage by Long Distance telephone. They have also devised telephone plans for more efficient handling of production, purchasing, administration, distribution, collections.

Because Bell System service is fast, economical, adaptable to specific needs, business more and more turns to the telephone.

BELL TELEPHONE SYSTEM

WHY NOT SAY "HELLO" TO MOTHER AND DAD?
—RATES ARE LOWEST AFTER 8:30 P. M.

G-E Campus News



STREAMLINED MOTOR

The new automobiles and airplanes have nothing, as far as streamlining goes, on an electric motor recently manufactured by General Electric. And undoubtedly many visitors to Langley Field, in Virginia, where the motor is now located, will think it some kind of miniature "Zeppelin." The motor is being used in investigations of the noises made by various types of propeller, the objective, of course, being to design a propeller in which noise is reduced to the practical minimum.

The motor, of the wound-rotor induction type, rated at 200 horsepower, is probably the first of its kind ever built. The propellers are mounted directly on the motor shaft, and can be run at speeds of between 1000 and 3600 rpm. The noises are picked up by a microphone and analyzed by means of special measuring devices.

The motor was designed by C. J. Koch, M.I.T., '24, and M. H. Wells, Syracuse, '02; and the control by A. Sikorsky, Washington State, '16.

CHARLES PROTEUS STEINMETZ

"Guide, philosopher, and friend" to his generation of electrical engineers, he would have been 69 years old had he lived until April 9. From his 30 years of work with General Electric came the mathematical formulas involving alternating current, the discovery of the laws of hysteresis, and methods of protecting transmission lines from lightning damage. These, to name a few, were basic aids in establishing present-day standards of electric service.

Yet, the heritage left by Steinmetz is the memory of not only a great scientist but of an essentially charming, kindly, helpful man of wide interests.

Out of the past, on the night of April 7, his voice spoke to radio's thousands—a voice that lives on a strip of film, evidence of our victory over time. Thus was inaugurated a three-day tribute to one who was loved for his human qualities as well as revered for his engineering achievements.

LESS NOISE

Until recently, noise has been regarded as a necessary evil, something that has come quite naturally with higher speeds and more complex civilization. But someone noticed that noise gives us the "jitters", rubber tires began to appear on milk wagons, and rubber cushions on ash cans. So, when General Electric was developing its air-conditioning units, noise became an important factor. Propeller-type fans, which had to run 24 hours a day to circulate air, were used, and they made too much noise for comfort. The Research Laboratory was given the job of doing something about it.

Research scientists examined the blades and found that on conventional fans all parts of the blade did not push air at the same rate of speed. In some cases, in fact, some parts pulled air back instead of pushing it forward. Blades on which every bit of surface pushed air at approximately the same speed were designed. And lo! not only was the efficiency of the fan tremendously increased, but the fan was quiet. Furthermore, a system was evolved whereby accurate fan noise rating is possible. As a result, air-conditioning units which make no more noise than is present in a closed room on a quiet day were developed. This quiet fan development was done under the direction of K. D. McMahan, Oklahoma A. & M., '29, of the G-E Research Laboratory.

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GENERAL ELECTRIC